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HANDBOOK OF MAINTENANCE INSTRUCTIONS

FOR

WESTON MODEL 790

RADIO RECEIVER ANALYZING EQUIPMENT

~~RESTRICTED~~

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(For Official Use Only)

Approved: 25 August 1944

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LIST OF REVISED PAGES ISSUED

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FAILURE REPORT

FOR U. S. ARMY AIR FORCE PERSONNEL.

In the event of malfunctioning, unsatisfactory design or unsatisfactory installation of any of the component units of this equipment, or if the material contained in this book is considered inadequate or erroneous, an Unsatisfactory Report, AAF Form No. 54 or a report in similar form shall be submitted in accordance with the provisions of Army Air Force Regulation No. 15-54, listing:

1. Station and organization.
2. Nameplate data (type number, serial number, or complete nomenclature if nameplate is not attached to the equipment).
3. Date and nature of failure.
4. Airplane model and serial number.
5. Remedy used or proposed to prevent recurrence.
6. Handbook errors or inadequacies, if applicable.

FOR U. S. NAVY PERSONNEL.

Report of failure of any part of this equipment during its guaranteed life shall be made on Form N. Aer. 4112 "Report of Unsatisfactory or Defective Material" or a report in similar form and forwarded in accordance with the latest instruction of the Bureau of Aeronautics. In addition to other distribution required, one copy shall be furnished to the Bureau of Ships, and to the Inspector of Naval Materiel, Newark, New Jersey. Such reports of failure shall include:

1. Reporting activity.
2. Nameplate data (type number and serial number or complete nomenclature if nameplate is not attached to the equipment).
3. Date placed in service.
4. Part which failed.
5. Nature and cause of failure.
6. Replacement needed (yes-no).
7. Remedy used or proposed to prevent recurrence.

FOR BRITISH PERSONNEL.

Form 1022 procedure shall be used when reporting failure of radio equipment.

DESTRUCTION OF ABANDONED MATERIEL IN THE COMBAT ZONE

In case it should become necessary to prevent the capture of this equipment and when ordered to do so, DESTROY IT SO THAT NO PART OF IT CAN BE SALVAGED, RECOGNIZED, OR USED BY THE ENEMY. BURN ALL PAPERS AND BOOKS.

Means:—

1. Explosives, when provided.
2. Hammers, axes, sledges, machetes, or whatever heavy object is readily available.
3. Burning by means of incendiaries such as gasoline, oil, paper, or wood.
4. Grenades and shots from available arms.
5. Burying all debris or disposing of it in streams or other bodies of water, where possible and when time permits.

Procedure:—

1. Obliterate all identifying marks. Destroy nameplates and circuit labels.
2. Demolish all panels, castings, switch- and instrument-boards.
3. Destroy all controls, switches, relays, connections, and meters.
4. Rip out all wiring and cut interconnections of electrical equipment. Smash gas, oil, and water-cooling systems in gas-engine generators, etc.
5. Smash every electrical or mechanical part, whether rotating, moving or fixed.
6. Break up all operating instruments such as keys, phones, microphones, etc.
7. Destroy all classes of carrying cases, straps, containers, etc.
8. Bury or scatter all debris.

DESTROY EVERYTHING!

GUARANTEE

This Model 790 Radio Receiver Analyzing Equipment including all parts and spare parts, except vacuum tubes, batteries, rubber, and material normally consumed in operation, is guaranteed for a period of one year from the date of delivery of the equipment to and acceptance by the Government with the understanding that all such items found to be defective as to material, workmanship, or manufacture will be repaired or replaced f.o.b. any point within the continental limits of the United States designated by the Government, without delay and at no expense to the Government; provided that such guarantee will not obligate the contractor to make repair or replacement on any such defective items unless the defect appears within the aforementioned period and the contractor is notified thereof in writing within a reasonable time and the defect is not the result of normal expected shelf life deterioration.

WARNING

OPERATION OF THIS EQUIPMENT MAY PLACE THE OPERATOR IN CONTACT WITH VOLTAGES AS HIGH AS 1000 VOLTS. THESE VOLTAGES ARE DANGEROUS TO LIFE. OPERATING PERSONNEL MUST AT ALL TIMES OBSERVE ALL SAFETY REGULATIONS.

WARNING

THIS EQUIPMENT CONTAINS UNUSUALLY DELICATE INSTRUMENTS. IN ORDER THAT THEY MAY NOT BE ACCIDENTALLY DAMAGED, IT IS STRONGLY RECOMMENDED THAT THESE INSTRUCTIONS BE STUDIED WITH GREAT CARE IN THEIR ENTIRETY BEFORE ATTEMPTING TO USE ANY OF THE INSTRUMENTS.

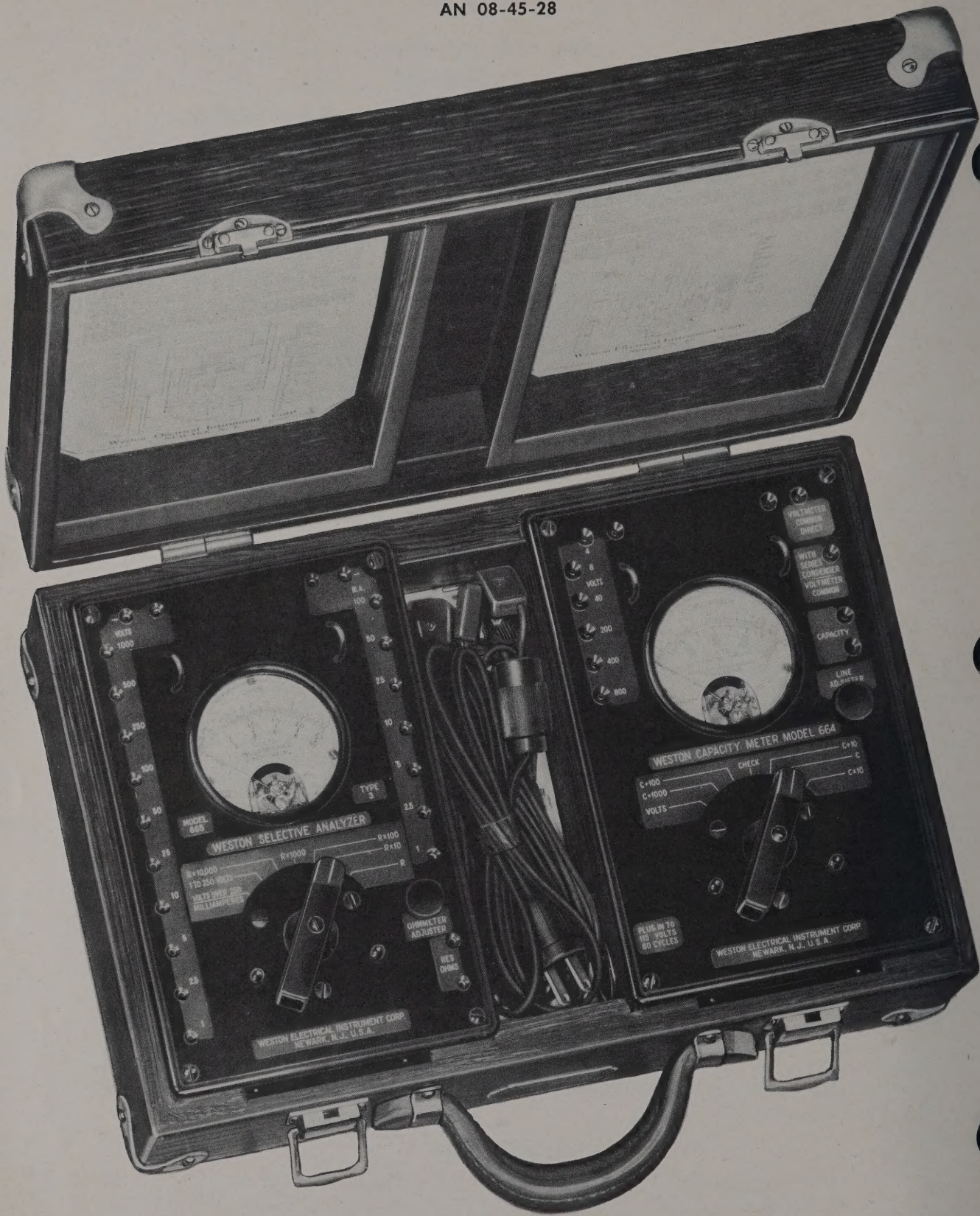


Figure 1—Model 790 Radio Receiver Analyzing Equipment

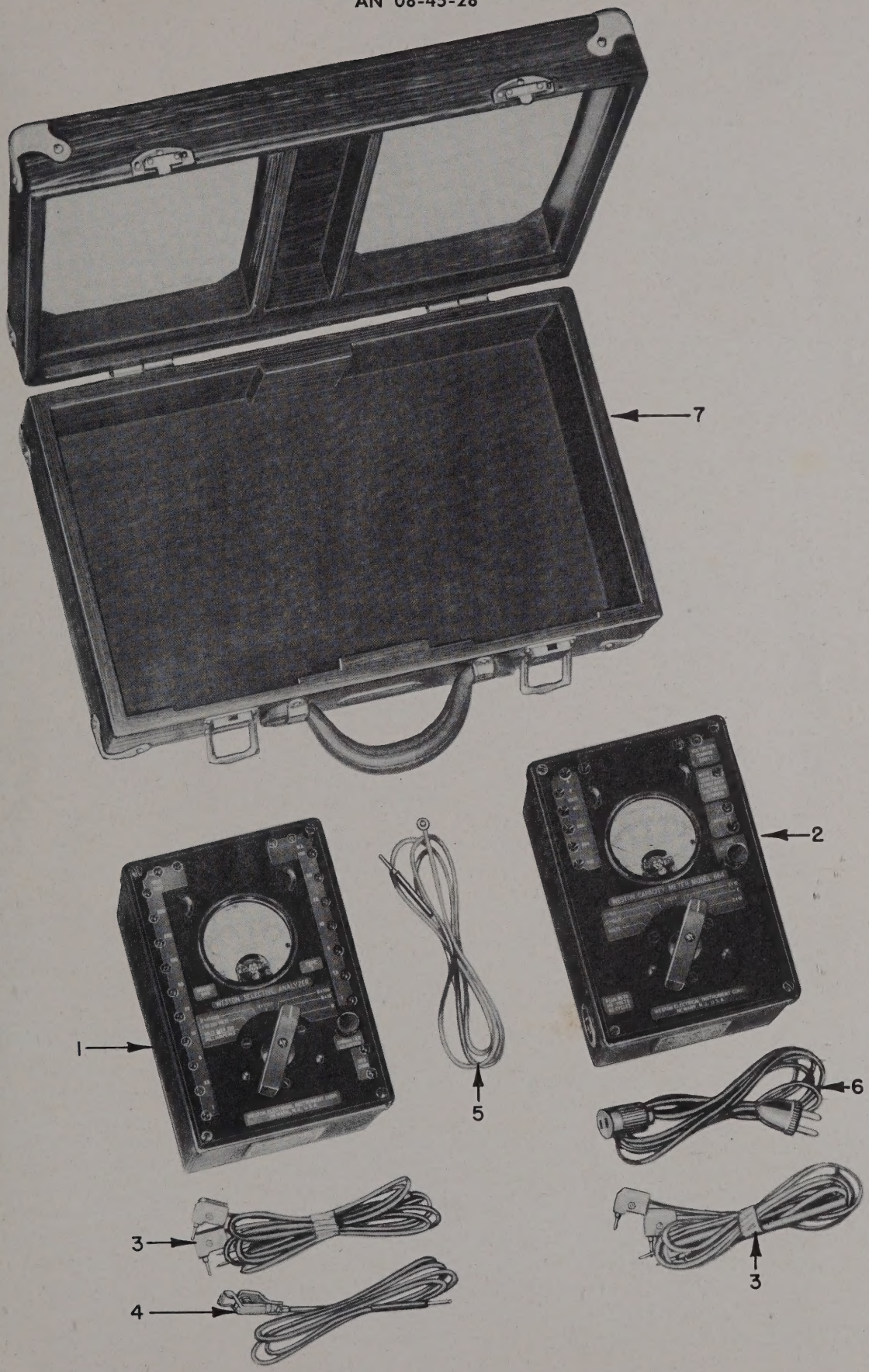


Figure 2—Model 790 Radio Receiver Analyzing Equipment Components

SECTION I

DESCRIPTION

1. This Handbook is issued as the general basic technical instructions for the Weston Model 790 Radio Receiver Analyzing Equipment.

2. The Handbook contains descriptive data and instructions for the operation and maintenance of the above equipment.

3. EQUIPMENT SUPPLIED.

Quantity per Equipment	*Manufacturer's Type No.*	*Nomenclature*	*Overall Dimensions*	*Weight*	*Numerical Series of Reference Numbers Figure 2*
1	Model 665 Type 3	D. C. Volt/Milliampere/Ohm Meter.	L. 8¼″ W. 5½″ H. 3⅞″	4.70 lb.	1
1	Model 664 Type 3	A. C. Volt/Capacity Meter.	L. 8¼″ W. 5½″ H. 3⅞″	4.0 lb.	2
2	.....	Test leads, including one red lead and one black lead each with polished steel prods and elbow pin terminals for use with the instruments.	L. 4′	.12 lb.	3
1	.....	Ground lead with connector plug.	L. 4′	.06 lb.	4
1	.....	Output connector lead.	L. 4′	.04 lb.	5
1	.....	A. C. line attachment cord with plug for Model 664 instrument.	L. 6′		6
1	.....	Oak carrying case.	L. 14⅜″ W. 11⅜″ H. 5⅜″	4.5 lb.	7

4. GENERAL DESCRIPTION.

a. The Model 790 Radio Receiver Analyzing Equipment consists of two multi-range instruments equipped with moulded bakelite panels and metal cases. The meters and leads as listed in paragraph 3 this section are all enclosed in a heavy oak carrying case, provided with a leather carrying handle. The case is arranged with a compartment at either end for holding the Model 665 and Model 664 units. The middle compartment is used for storing the leads for the instruments.

b. In servicing radio receiving equipment, two generally accepted methods are in vogue, one is the "dynamic" method whereby measurements are made of the actual performance of the equipment in the reception of radio signals as well as the stage by stage performance, measurements being made by impressing actual measurable radio frequency signals on the different stages of the receiver, and measuring the sensitivity, selectivity, etc., with the equipment in operating condition. This necessitates the use of a calibrated source of variable frequency input signals as a Standard Signal Generator and is valuable in determining the condition of equipment but not particularly advantageous as a method of isolating difficulties arising from damaged or malfunctioning component parts.

c. The second method is the "static" method, whereby measurements are made by electrical indicating instru-

ments of the voltages, current, resistances, and capacitances associated with the various circuits. This method is predicated on the basis that if all the various component parts of the radio receiver are in operating condition and their electrical characteristics intact, the equipment will function properly as a whole.

d. The Model 790 Radio Analyzing Equipment is designed to permit the latter method of testing to be accomplished, and has all of the instruments necessary for the measurement of d-c voltages up to 1000 volts, d-c currents, up to 100 milliamperes, a-c voltages up to 800 volts, capacitances up to 200 microfarads, and resistances up to 10 megohms as well as accessories necessary to permit point-to-point readings to be taken.

e. The Model 790 Equipment is specifically designed for the purposes stated and features of ruggedness, flexibility and extreme sensitivity are a part of the design of the equipment. The latter point is one of considerable importance. Commercially standard instruments possess a voltage sensitivity of 1000 ohms per volt, i.e., the voltmeter requires 1 milliampere for full scale deflection. This current is often of the same order as, or considerably greater than the current flowing in the circuits under measurement (such as vacuum tube plate and shield grid circuits) which usually include high resistances for voltage dropping and filter purposes. These resistances are of such a value that the proper voltage is obtained at their terminal, feeding the items with which they are associated (such as a vacuum tube) when the normal current drawn by this item is flowing. As a low sensitivity voltmeter is connected to such a circuit, the excessive current consumed by the meter creates an excessive voltage drop in the resistor and produces erroneous voltage readings.

f. The d-c instrument in the Model 790 equipment has a sensitivity of *20,000 ohms per volt* and requires about *50 microamperes* for full scale deflection. This sensitivity is available on all ranges up to and including the 250-volt range. The 500- and 1000-volt ranges, however, are 1000 ohms per volt. The small current on the 20,000 ohm per volt range is, in general, insignificant in comparison with the circuit currents so that substantially correct voltages are indicated under all conditions.

5. DETAILED DESCRIPTION.

a. Both the Model 665 and the Model 664 instruments consist of moulded bakelite panels on which are mounted the indicating instruments proper and the operating accessories. Supported by the panels and contained within the protective steel case are various multiplier and shunt networks, making entirely self-contained assemblies, except for the batteries of the Model 665 instrument which are secured to the bottom of its case. The panels are secured to the steel case by four screws and lifting rings are provided on the panels in order that the instruments may be removed from the wooden case for test purposes. The cases are of such size as to fit snugly into their respective compartments in the carrying case.

Figure 3—Panel View of Model 665 Type 3 D. C. Volt/Milliampere/Ohm Meter

b. MODEL 665 D. C. VOLT/ MILLIAMPERE/OHM METER.

(1) The Model 665 instrument is a multi-purpose d-c meter suitable for measurement of voltages, current, and resistance, its internal wiring diagram is shown in figure 8 and its panel appearance in figure 3.

(2) The Model 665 instrument has the following full scale ranges:

Voltage	*Current*	*Resistance*
1.0 volts	1.0 milliamperes	1,000 ohms
2.5 volts	2.5 milliamperes	10,000 ohms
5.0 volts	5.0 milliamperes	100,000 ohms
10.0 volts	10.0 milliamperes	1 megohm
25.0 volts	25.0 milliamperes	10 megohms
50.0 volts	50.0 milliamperes	
100.0 volts	100.0 milliamperes	
250.0 volts		
500.0 volts		
1000.0 volts		

(3) The instrument consists fundamentally of a d-c microammeter, reading full scale deflection on *50 microamperes* which in combination with a series of multipliers and shunts is utilized for reading either voltage or current. A source of 15 volts d-c (two 7.5-volt dry batteries) is provided which permits the reading of resistance values.

(4) The various ranges of voltage or current are obtained by means of small pin jacks by which the proper multiplier or shunt is selected.

(5) The resistance ranges are selected by means of a large rotary switch which connects the proper resistance network for the range selected. A switch position is available for voltage ranges from 1 to 250 volts and a second switch position is used for the 500- and 1000-volt ranges and all milliammeter ranges.

(6) A small rheostat on the front of the panel is provided for the purpose of compensating for variation of battery voltage when resistance values are measured.

(7) As a voltmeter, the sensitivity is *20,000 ohms per volt* up to and including the 250-volt range and *1000 ohms per volt* on the 500- and 1000-volt ranges. Therefore, the full scale current consumption is 50 microamperes up to and including the 250-volt range and one milliampere on the 500- and 1000-volt ranges.

(8) It will be noted that current and voltage ranges have been provided so that no range bears a ratio to the next in excess of 2.5 and for most ranges the ratio is 2. Accordingly, readings can usually be taken above the half scale mark thereby greatly improving the accuracy.

(9) The Model 665 instrument is rated with an accuracy of 2.5% for all scales of voltage or current.

Note

Particular attention is directed to the standard method of rating meters for accuracy. The percentage figure of accuracy is always with reference to the full scale reading (for the range in use) to be added or subtracted in electrical units from the readings obtained, thus a 2.5% instrument when used for example on the 100-volt range may be expected to indicate accurately to within ±2.5 volts, if 100 volts is being measured the *actual percentage* accuracy is 2.5%, but if 10 volts is being measured, the actual accuracy is only 25% (2.5 volts in 10). To obtain the most accurate readings always use the lowest range that will permit the pointer to remain on-scale.

Figure 4—Panel View of Model 664 Type 3 A. C. Volt/Capacity Meter

c. MODEL 664 A.C. VOLT/CAPACITY METER.

(1) The Model 664 instrument is a multi-purpose a-c meter, suitable for the measurement of voltage and capacity. Its internal wiring diagram is shown in figure 9 and its panel appearance is illustrated in figure 5.

(2) The Model 664 instrument has the following full scale ranges:

VOLTAGE	*CAPACITANCE*	
4 volts	*Minimum*	*Maximum*
8 volts		
40 volts	.0001 mfd.	.02 mfd.
200 volts	.001 mfd.	.2 mfd.
400 volts	.01 mfd.	2.0 mfd.
800 volts	.1 mfd.	20.0 mfd.
	1.0 mfd.	200.0 mfd.

(3) The instrument consists fundamentally of an a-c copper oxide rectifier type microammeter, reading full scale on 230 microamperes. This instrument in combination with suitable multipliers and an accurately adjustable source of a-c potential is utilized for reading either voltage or capacitance.

(4) External connections for voltage measurements are made by plugging the test leads into small pin jacks located on the face of the panel. Markings adjacent to the pin jacks indicate the various ranges available. When used as a voltmeter the instrument has a sensitivity of 1000 ohms per volt requiring one milliampere for full scale deflection. A single switch position is available for all volt ranges. In addition, a switch position marked "CHECK" is provided for setting the pointer to the full scale or "infinite capacity" position before taking capacity readings. All capacity ranges are selected by the other switch positions. Condensers having capacities from 0.0001 to 200 microfarads may be measured.

(5) A small rheostat on the front of the panel is provided for the purpose of compensating for variations in a-c line voltage when reading capacitances.

(6) An extra jack marked "WITH SERIES CONDENSER—VOLTMETER COMMON" is provided for the purpose of blocking any d-c potentials which might be present across the source of a-c being measured.

(7) As a voltmeter, the 230-microampere instrument is shunted so as to read full scale on one milliampere, making the meter sensitivity 1000 ohms per volt for all ranges.

SECTION II

OPERATION AND ADJUSTMENT

1. STOWAGE AND CARE.

a. When not being used, the various component parts of the Model 790 equipment should be stowed in the oak carrying case which in turn should be stowed in as dry a place as is available.

b. Before stowing, the various cords and leads should be checked with the list in paragraph 3 section I to preclude their loss.

c. The Models 665 and 664 instruments should preferably be removed from the oak carrying case for use. Their metal cases are completely insulated from all electrical circuits so that they may be placed without fear of malfunctioning due to grounding or contact with parts of the circuits under measurement.

Note

In view of the sensitivity and cost of the Model 665 instrument, it is recommended that it not be used for routine continuity test but that the relatively smaller and less expensive ohmmeters which are usually available be used for this purpose.

d. In using this equipment, it should be borne in mind that both the Model 665 and Model 664 instruments are extremely sensitive and cover a wide range of electrical values. Accordingly, extreme care should be exercised to avoid injuring the meter pivots, bending the pointer by overloading or burning out of the moving elements, multipliers or shunts. In furtherance of this, the following precautions should be observed.

CAUTION

Don't drop the instruments.

In measuring current or voltage, *always* start with the highest range and work down, regardless of what voltage or current value might be expected.

In measuring resistance or capacitance *always* disconnect the equipment in which the units are located, from all power connections.

Never connect two functions such as current and voltage of either instrument to an equipment or item at the same time. *Always* remove all cords excepting the two required for the type of measurement being made.

e. In order to obtain the greatest accuracy of measurement the following should be observed.

(1) For voltage and current measurements use the range that will produce the nearest to full scale reading.

(2) For resistance and capacitance measurements use the range that will give the nearest to mid-scale readings.

2. OPERATION AND ADJUSTMENT.

a. D. C. VOLTAGE.

(1) Use the Model 665 instrument. Plug a black test cord (with prod) into the common jack at the upper left-hand corner of the panel marked "-VOLTS". Plug a red test cord into a jack along the left-hand side of the panel marked with a full scale range sufficiently high to cover the voltage to be measured. Set the large switch below the meter to either the "1-250 VOLT" position or the

"VOLTS OVER 250"
"MILLIAMPERES"

position, according to whether voltages above or below 250 volts are to be measured. The test prods are used in the conventional manner. The proper multiplying factor must be applied to the scale reading in accordance with the range used.

(2) Always start with a range well above the range of the expected voltage; take an approximate reading, then transfer the positive cord to the range giving as near full scale deflection as possible for the voltage in question.

b. D. C. CURRENT.

(1) Use the Model 665 instrument. Plug a black test cord (with prod) into the common jack at the upper right-hand corner of the panel marked "-MA". Plug a red test cord into a jack along the right-hand side of the panel marked with a full scale range sufficiently high to cover the current to be measured. Set the large switch below the meter to the

"VOLTS OVER 250"
"MILLIAMPERES"

position. The test prods are used in the conventional manner, the negative (black) lead connecting to the negative lead *from the power source.* The proper multiplying factor must be applied to the scale reading in accordance with the range used.

(2) Always start with a range well above the range of the expected current, take an approximate reading, then transfer the positive cord to the range giving as near full scale deflection as possible for the current being measured.

c. A. C. VOLTAGE

(1) Use the Model 664 instrument. Where no d-c component is present, plug one test cord (with prod) into the upper jack on the right-hand side of panel marked "Voltmeter Common Direct" and the other test cord into a jack along the left-hand side of the panel marked with a full scale range sufficiently high to cover the voltage to be measured. Set the large switch below the meter to the position marked "Volts". The test prods are used in the conventional manner. The proper multiplying factor must be applied to the scale reading in accordance with the range used. Be sure, when using the 4 and 8 volt range, to read the small middle scale which differs from the high voltage scales because the resistance of the copper oxide rectifier varies with the current density and is an appreciable part of the total circuit resistance of the 4- and 8-volt ranges.

(2) Always start with a range well above the range of the expected voltage, take an approximate reading, then transfer the range cord to the range giving as near full scale deflection as possible for the voltage being measured.

(3) Where a d-c component is present with the a-c voltage to be measured, such as in the measurement of hum level of a rectifier power unit or a-c voltage across a device in the plate circuit of a vacuum tube, the common lead should be used in the jack marked "WITH SERIES CONDENSER—VOLTMETER COMMON". This places a 0.25 microfarad capacitor in series with the meter circuit to block the d-c voltage. However, this capacitor is of such size as to have a relatively high reactance (approximately 10,600 ohms at 60 cycles) with respect to the instrument resistance on certain voltage ranges and frequencies, so that the voltage readings obtained may be expected to be in error below the 40-volt range, the instrument resistance being low on the 4- and 8-volt ranges.

d. RECEIVER OUTPUT MEASUREMENTS.

(1) Use the Model 664 instrument. The receiver output being an a-c voltage, sometimes with and sometimes without a d-c component, is measured as described under paragraph *c.*, this section excepting that the question of receiver termination must be considered as well as the measurement of output in terms of milliwatts.

(2) Where the output impedance is low (i. e., the Navy standard 600 ohms or lower) the receiver output should be shunted with a resistance equal to the output impedance (or in some cases the proper impedance headphones) and the voltage read across this terminal load. For high impedance outputs (such as 20,000 ohms) the instrument resistance will serve as a termination on the 4- and 8-volt ranges, having 4,000 and 8,000 ohms resistance on the respective ranges. For the 40-volt range, a terminating resistance should be used, of such value that with the instrument in shunt the combined resistance is equal to the receiver output impedance. This would be 40,000 ohms for standard 20,000-ohm output impedances.

(3) The reading obtained with the Model 664 instrument will be in terms of volts. Receiver outputs, however, are best expressed in terms of milliwatts to permit comparisons between equipments without the necessity of taking cognizance of the respective output impedances. The wattage can be computed from the measured voltage and the terminal impedance by the usual relation

$$W = \frac{E^2}{R}$$

In order to facilitate such conversion with the minimum of computation, a family of curves is shown on figure 8 in which the relationships between output volts and milliwatts for the most used and common values of output impedances are plotted.

e. RESISTANCE.

(1) Use the Model 665 instrument. Plug a pair of test cords (with prods) into the jacks "RES OHMS" on the lower right-hand side of the panel, the black cord in the lower jack. Set the large switch below the meter to the position marked with a suitable multiplying factor that will permit a reading, as near HALF scale as possible (half scale readings produce the greatest accuracy when measuring resistance). Short circuit the test prods

and adjust the "OHMMETER ADJUSTER" control until the meter reads exactly full scale. Measurements are then made in the conventional manner, applying the multiplying factor indicated by the dial switch position to the meter readings obtained.

(2) In measuring the resistance of polarized devices or those possessing rectifying characteristics such as electrolytic capacitors, it is essential that the proper polarity of the voltage source in the instrument be applied to the proper terminal of the device being measured, i. e., negative to negative, in order to avoid damage to the device and that correct values of resistance be obtained. The lower jack on the panel is negative.

f. CAPACITY.

(1) Use the Model 664 instrument. A source of 100-115 volts, 60 cycle, single phase a-c is required. The instrument should be connected to this voltage supply by means of the line cord. The test cords should be plugged into the jacks marked "CAPACITY", the switch below the meter set on the "CHECK" position, and the "LINE ADJUSTER" control varied until the meter reads exactly full scale. The large switch below the meter should then be set on a proper range marked with a multiplying factor that will give approximately HALF scale reading for the value of capacity to be measured. (Half scale readings produce the greatest accuracy when measuring capacity.)

(2) Measurements are then made in the conventional manner, applying the multiplying factor indicated by the dial switch position to the meter readings obtained.

(3) The measurement of capacitance with the Model 664 instrument is in reality a measurement of capacitive reactance or impedance and is accomplished by impressing a measured standard voltage on the indicating meter through a multiplier resistance and the unknown capacitance, which functions as an additional multiplier. The instrument proper is calibrated directly in terms of microfarads.

(4) It must be realized that with this method of measuring capacitance, accuracy is predicated on *four* factors and in making such measurements, certain precautions should be observed in order that erroneous results are not obtained.

(a) The inherent meter accuracy and the value of capacitance under measurement. In the measurement of capacitance by the reactance method such as is employed in the Model 664 instrument, an exception is present with respect to the note under paragraph *b.* (8), section I, i. e., the best accuracy is not obtained at full scale, but at approximately half scale. Accordingly, insofar as is practicable, the range should be so chosen with respect to the size of the capacitance under measurement that as near half scale reading as possible be obtained.

(b) The accuracy of the a-c frequency used with respect to the 60 cycle frequency for which the scale is calibrated. The basic measurement being one of impedance which varies inversely with frequency, any variation of the supply frequency from 60 cycles, for which the scale is calibrated, will introduce proportionate errors. That is, if the frequency is 5 percent high the capacity readings will be 5 percent high, and if 5 percent low, the reading will be 5 percent low.

(c) The purity of the capacitive reactance of the unknown capacitance, i. e., the ratio of any shunt resistance (leakage, etc.) to the reactance. The method of measurement is similar in principle to the method employed in the Model 665 instrument for measuring resistance, excepting that a-c is used as a source of voltage in lieu of batteries and the impedance of the unknown capacitance is used as a multiplier instead of the unknown resistance. The impedance is equal to

$$\frac{1}{Z} = \sqrt{\left(\frac{1}{X_c}\right)^2 + \left(\frac{1}{R}\right)^2}$$

where X_c is the reactance of the unknown capacitance and R is any equivalent shunt resistance that might be present in the circuit either external to or as a part of the capacitor being measured. If the resistance (R) is greater than 10 times the capacitive reactance it is unimportant, but if considerably smaller than this, extremely erroneous readings will result. This condition is more often met when measuring low values of capacitance, such as receiver capacitors, antennas, etc., where the reactance is high and the leakage resistance may be proportionately low. Because of this it is recommended that, either as a standard procedure, or at least in cases where the measured capacity appears to be unusually high, a leakage test be made with the ohmmeter of the Model 665 instrument to ascertain that the capacitor under measurement does not possess low leakage resistance. Even such a test is not infallible because of the fact that a capacitor will often show extremely high leakage resistance at the low voltages employed in the Model 665 ohmmeter circuit, but will show low resistance at higher voltages. If a source of *direct current* is available, a more rigorous and representative method is described in paragraph 2. *g.*, this section.

(d) The relation between the grounded side of a capacitor and a grounded a-c line. Occasionally, when measuring low values of capacity, one side of which is grounded, the natural capacitance of one side of the a-c supply line or a ground thereon, together with the unequal distributed capacitance of the line transformer in the instrument will result in a partial shunt being put on the multiplier resistance in the instrument, which is quite high on the lowest range (364,000 ohms) resulting

in erroneous readings. For best accuracy, the lower "CAPACITY" jack should be connected to the grounded terminal of the capacitor under measurement and the line plug reversed to ascertain the direction giving the lowest reading of capacity which should be used.

g. CAPACITOR LEAKAGE.

(1) The standard method of expressing capacitor leakage is not in terms of ohms or mhos, but in terms of MICROAMPERES PER MICROFARAD AT RATED WORKING VOLTAGE. If a source of *direct current* of the general order of magnitude as the working voltage of the capacitor but not in excess of 250 volts, is available, the following procedure may be followed:

(a) Connect the capacitor and the Model 665 voltmeter (using a scale giving the nearest to full scale deflection) in series across the d-c source which should be adjusted so as not to exceed the d-c rating of the capacitor. For electrolytic capacitors it is ESSENTIAL that the positive line be connected to the positive terminal of the capacitor.

1. Short circuit the capacitor and read the voltage. This is the voltage of the source.

2. Remove the short circuit and again read the voltage. This is the voltage being impressed across the meter. If the reading is the same as under *1.*, the capacitor is worthless.

3. Read or interpolate the "0—5" scale of the meter not changing the range, recording this value multiplied by 10 in terms of microamperes. This is the leakage current through the capacitor, (the instrument reading 50 microamperes full scale).

4. Subtract the voltage reading of *2.* from that of *1.* (This is the voltage across the capacitor.) Multiply this value by the ratio of the rated working voltage of the capacitor to this value and divide by the capacity value. This is the leakage in standard terms of microamperes per microfarad at rated working voltage.

(2) EXAMPLE:—Assume a capacitor rated at 2.5 microfarads, 400 volts d-c (rated working voltage). A d-c source of 200 volts is available and is used.

Use the voltmeter on the 250-volt scale.

Under *1.* assume the reading was 200 volts.

Under *2.* assume the reading was 100 volts.

Under *3.* this corresponds to 20 microamperes (2×10).

Under *4.* we would have:

$$200 - 100 = 100, \frac{400}{100} \times \frac{20}{2.5} = 32 \text{ microamperes per microfarad.}$$

For good foil-paper by-pass capacitors the leakage should not exceed 2 microamperes/microfarads.

For mica capacitors the value should be practically zero if no leakage across the terminals exists.

For good electrolytic capacitors the leakage should not exceed 10 microamperes/microfarad.

SECTION III

THEORY OF OPERATION

1. RECEIVER TESTING.

a. GENERAL.

(1) In testing a radio receiver for trouble it is decidedly advantageous that an actual wiring diagram of the equipment be at hand as well as a table of the various terminal and tube socket voltages and currents to be expected from a properly operating equipment. In general not only are these data available in the apparatus instruction books, but such books also contain details of the proper test procedure.

(2) For equipment where such data is not available but properly operating duplicate equipments are at hand, it is recommended that complete data be obtained on the operative equipment and recorded for future use.

(3) If no data and no duplicate operative equipment are available, reference must be made to such data as is available on proper operating voltage and current values for the various vacuum tubes and these used as a basis of test.

(4) In approaching the problem of ascertaining the causes that have rendered a radio receiving equipment inoperative, consideration of three general premises will facilitate the testing.

(a) The equipment was properly designed and was at one time operative.

(b) Failure to operate is the result of failure of one or more component items, usually capacitors, resistors or wiring.

(c) Such items are subject to complete failure, rather than a slow change in characteristics as occurs with vacuum tubes.

(5) Accordingly, in many cases it is not essential to know the exact voltage to be expected at every point tested (under point-to-point testing) but merely the general order of voltage or its absence or presence.

b. SOCKET TERMINALS.

(1) In the process of either point-to-point testing

by the use of a voltmeter and test prods or by selective analyzing methods, it is extremely important that attention be given to the terminal arrangement of the various vacuum tube sockets with respect to the tube used.

(2) Figure 5 illustrates the terminal arrangements of 4, 5, 6, 7 and 8-prong sockets with respect to the different types of tubes used in each type of socket.

(3) It should be noted that the base diagrams in figure 5 are drawn and numbered as viewed from the bottom of the socket, which is the reverse of the pin numbers when looking down on the selective analyzer block. When working with the test prods on the rear of the socket in a receiver chassis, the pin numbers are as shown on the base diagrams.

c. METHOD.

(1) Two different procedures are used in the testing and analyzing of radio and electronic equipments. These involve the direct point-to-point method wherein the regular test leads are used with either the Model 665 or Model 664 instruments and connections made on the under side of the chassis to the socket terminals or other associated terminals, and the top chassis analysis method wherein adapters are used in the tube sockets with the tube in the top of the adapter, and readings taken with the test leads between any two of the radial tab contacts.

(2) The point-to-point method of testing may be employed with the equipment operating wherein voltage measurements are recorded. Using a common point, usually the chassis or the negative high voltage, as a reference point, each circuit is considered individually and the voltage tested and recorded at progressive points toward each tube element. A sudden loss of voltage indicates an open circuit, a short-circuited capacitor, or a burned out resistor, which can be individually isolated by further resistance tests.

(3) In the top chassis analysis method, adapters are used. The tubes are pulled one at a time, the correct adapter inserted in the socket, and the tube placed in the socket section of the adapter. This, in effect, brings out all tube element connections to the radial adapter connectors and permits readings to be made of the potential applied between any two elements. This method may be followed using the Navy Model OE-12, where the required adapters are provided.

(4) The Model 665 may be used for all potentials provided the equipment operates with d-c current for the filament or heater circuits. If potentials with respect to the cathode are required, the negative or black test lead should be connected to the cathode pin tab referring to the base chart diagram for the particular tube in question. The red lead from the instrument may then be connected to plate or screen circuits for positive potentials. For grid readings, the polarity should be reversed or in some cases the grid bias may be measured by taking the drop across the cathode resistor to chassis.

(5) If the filament energy for the tubes in the equipment is alternating current, the Model 664 instrument should be used for recording filament potentials. Never attempt to measure a-c filament voltage or current with the Model 665 instrument; it is a d-c meter. Take a-c voltage measurements with the Model 664 instrument. Always measure filament voltage across the filament.

(6) Never attempt to measure filament voltage from one side of filament to ground. In many Navy receivers the filament circuits (particularly for the output limiting tubes) are maintained at a high d-c potential with respect to ground.

SECTION IV

MAINTENANCE

1. TEST CORDS.

After considerable use, the test cords may become worn or frayed, usually where they enter the hard rubber sleeves of the test prods. When this occurs, the sleeve should be unscrewed and the lead cut off beyond the worn spot and resoldered to the tip.

2. BATTERIES.

The batteries for supplying voltage for the operation of the ohmmeter section of the Model 665 instrument is contained in the bottom of the metal case. These batteries are subject to deterioration either from use or more usually from age. When the meter pointer can not be brought to full scale with the test prods shorted, in the "OHMMETER" position and the "ADJ" rheostat at zero they should be replaced. Use only batteries similar to Burgess No. 5540, and be sure to reconnect the new batteries in the exact manner shown by the wiring diagram in figure 8, both as to voltage taps and polarity.

3. FAILURE OF PARTS.

In the event of failure of any component parts they should be requisitioned in accordance with the description given in the parts list. Should either indicating instrument proper fail it is unnecessary to return for repair or to requisition other than the meter itself. It should be clearly stated that the meter is from or for a Model 665 Type 3 or Model 664 Type 3 instrument, as supplied in Model 790 Radio Receiver Analyzing Equipment.

4. MULTIPLIER FAILURES.

Should one or more sections of either the voltmeter multipliers or the milliammeter shunts associated with the pin jacks of either meter fail, do not attempt to short circuit the bad section in any effort to keep the remaining ranges operative. These resistors all operate in series so that the absence of one section will introduce extremely bad errors in other ranges.

5. SERIES CONDENSER.

Should the Model 664 instrument when used with the "SERIES CONDENSER" to measure a-c voltage where a d-c component exists (such as in the measurement of ripple in a rectifier power unit) show a marked difference in reading when the leads are reversed, it is indicative of excessive leakage having developed in the Series Capacitor. In the absence of a replacement, it is feasible to use an external capacitor in series with the "Common" terminal of the instrument.

6. REQUISITIONING PARTS.

All requests or requisitions for replacement material should include complete descriptive data covering the part desired, in the following form:

1. Name of part desired.
2. Navy Type number (if assigned, including prefix and suffix as applicable).
3. Model designation (including suffix) of equipment in which used.
4. Navy Type designation (including prefix and suffix where applicable) of major unit in which part is used.
5. Symbol designation of part.
6. (a) Navy Drawing Number.
   (b) Manufacturer's Drawing Number.
7. Rating or other descriptive data.
8. Commercial designation.

SECTION V

SUPPLEMENTARY DATA

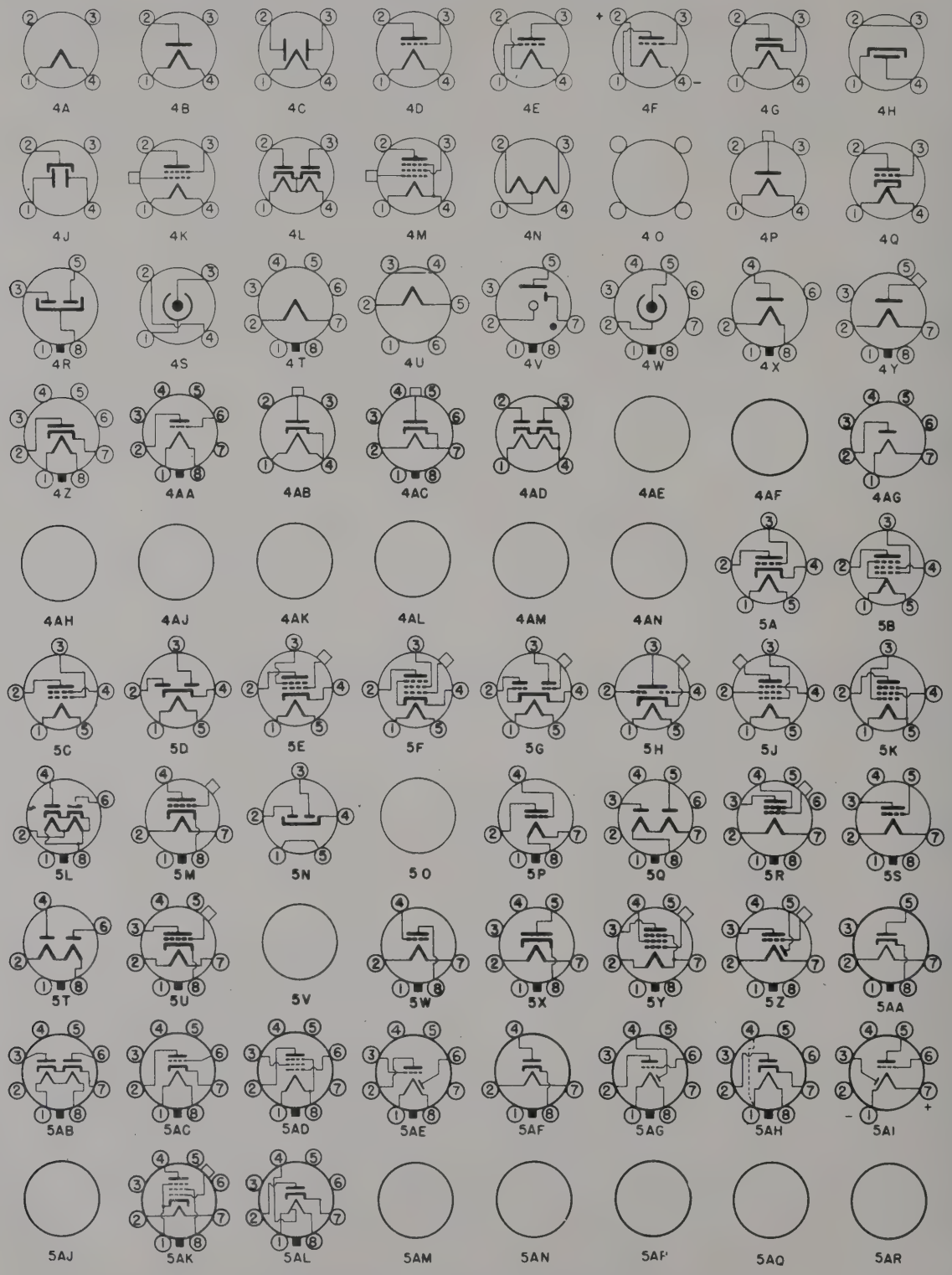


Figure 5—Tube Base Connections
Bottom View of Socket or Base of Tube

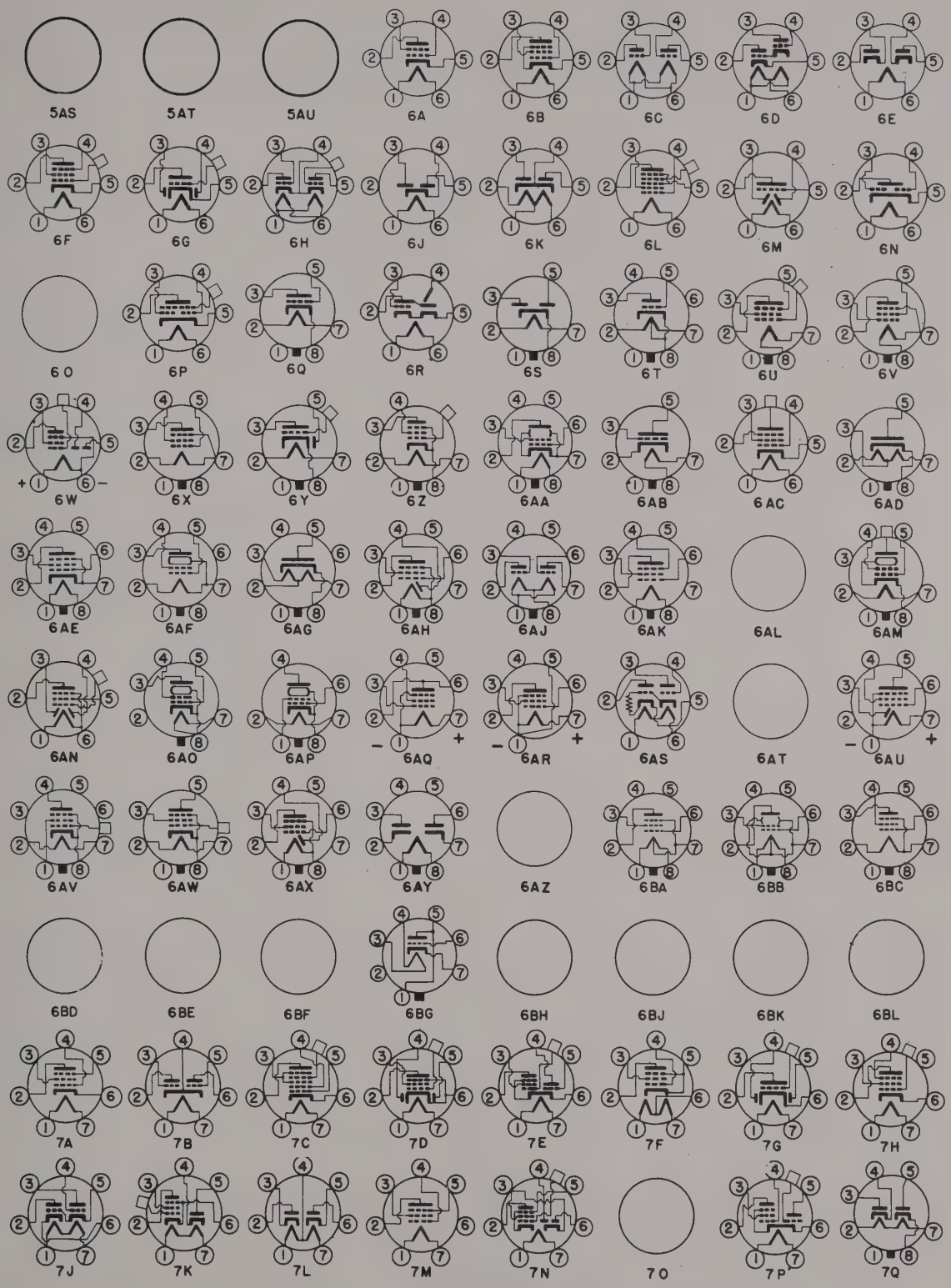


Figure 5—Tube Base Connections (Continued)
Bottom View of Socket or Base of Tube

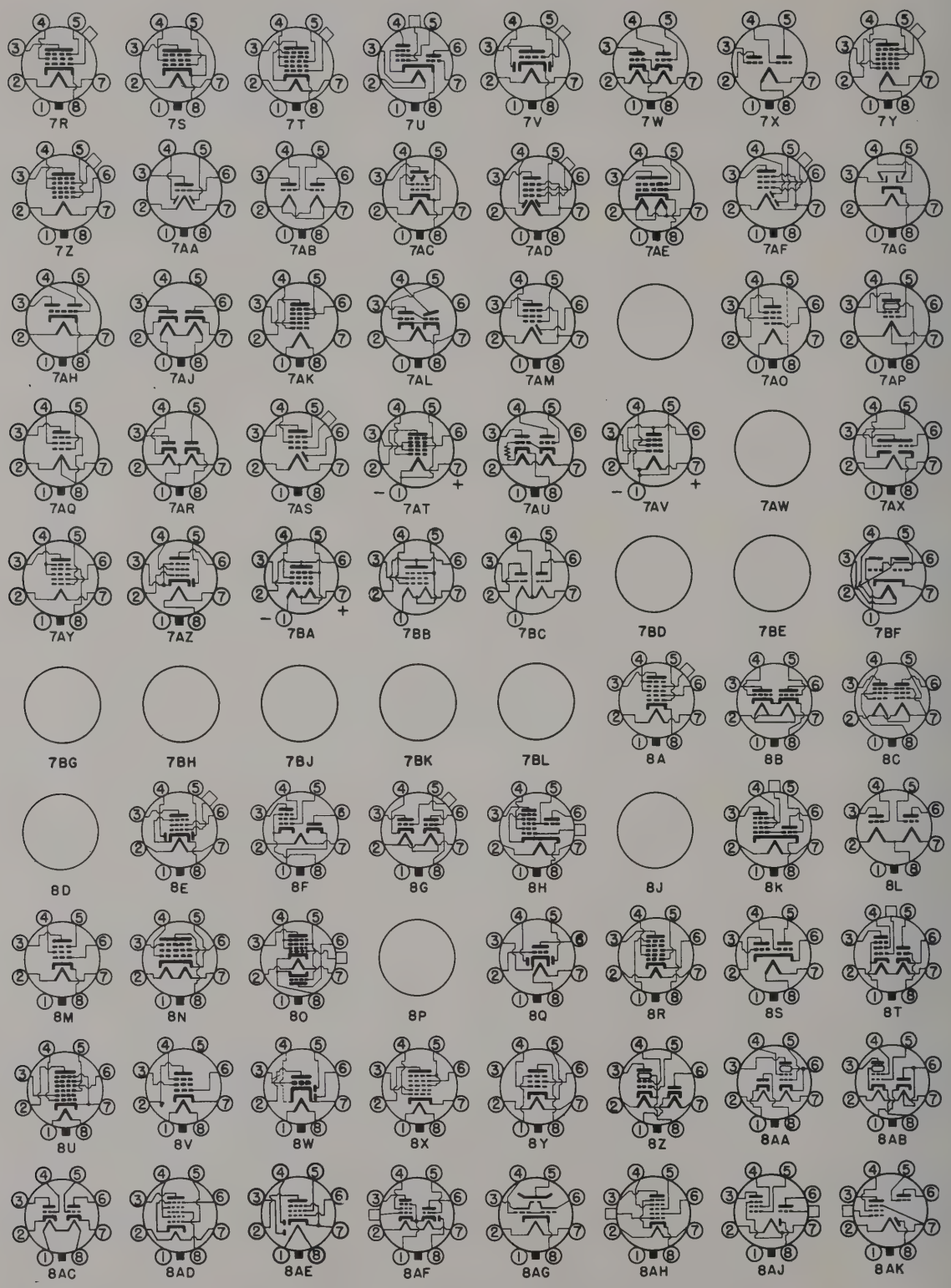


Figure 5—Tube Base Connections (Continued)
Bottom View of Socket or Base of Tube

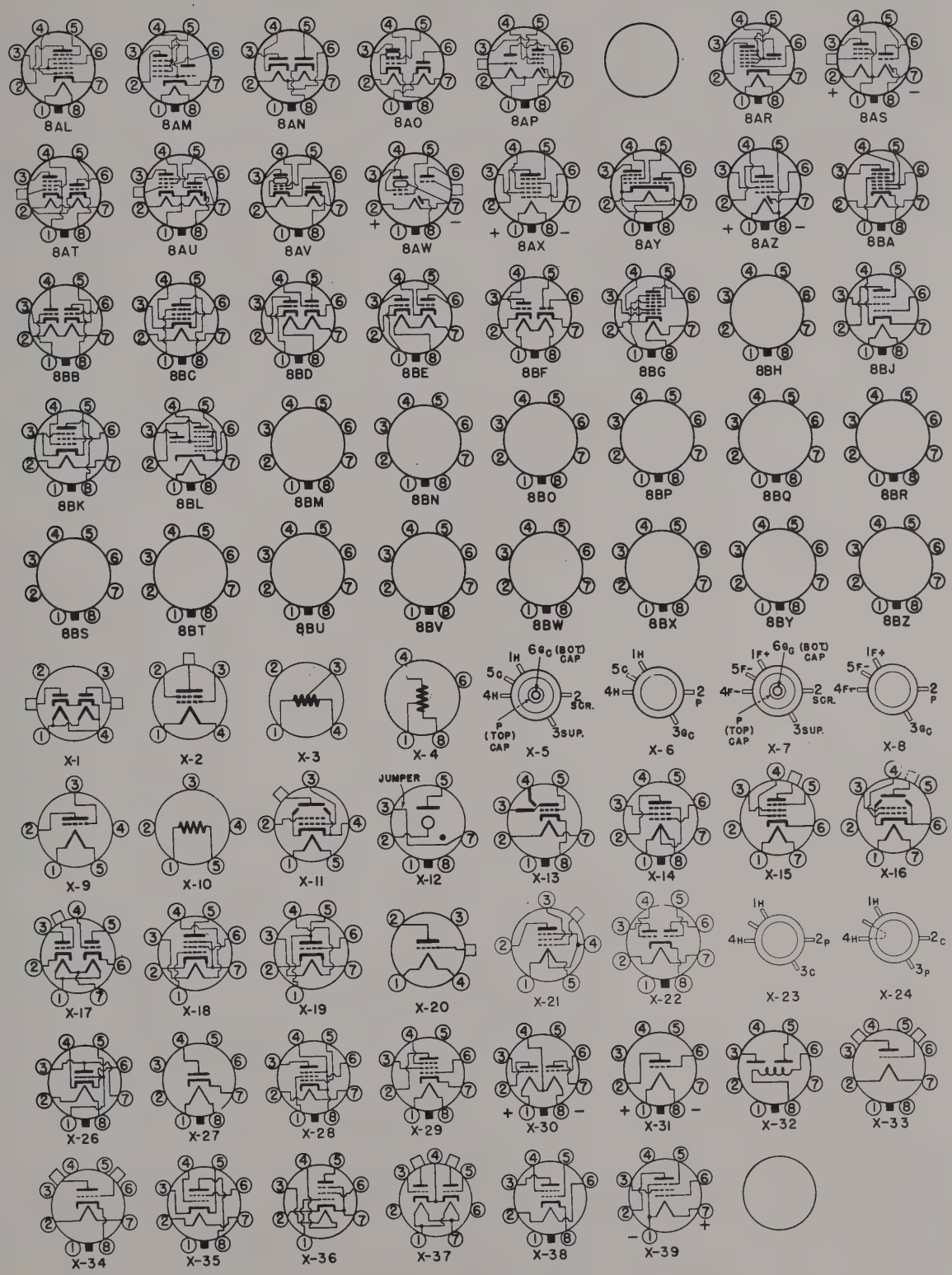


Figure 5—Tube Base Connections (Continued)
Bottom View of Socket or Base of Tube

TABLE I—TUBE BASE LIST

Tube Type	Base	Tube Type	Base	Tube Type	Base	Tube Type	Base	Tube Type	Base
00	4D	1N6-G	7AM	6AC6-G	7W	6N7	8B	7N7	8AC
00A	4D	1P1	4T	6AC7/1852	8N	6P5-G	6Q	7Q7	8AL
0A4	4V	1P5-G	5Y	6AD5-G	6Q	6P7-G	7U	7R7	8AE
0Z3	5N	1Q1	4T	6AD6-G	7AG	6Q6-G	6Y	7S7	8BL
0Z4	4R	1Q5-GT	6AF	6AD7-G	8AY	6Q7	7V	7T7	X-29
01	4D	1R1-G	4T	6AE5-GT	6Q	6R6-G	6AW	7V7	8V
01A	4D	1R5	7AT	6AE6-G	7AH	6R7	7V	7W7	8BJ
01AA	4D	1S1-G	4T	6AE7-GT	7AX	6S6-GT	5AK	7Y4	5AB
01B	4D	1S4	7AV	6AF5-G	6Q	6S7-G	7R	7Z4	5AB
1	4G	1S5	6AU	6AF6-G	7AG	6SA7	8R	8	4A
1A1	4A	1T1-G	4T	6AF7	8AG	6SA7-GT	8AD	9	4A
1A3	5AP	1T4	6AR	6AG5	X-36	6SC7	8S	10	4D
1A4-P	4M	1T5-GT	6X	6AG7	8Y	6SD7-GT	8N	12A	4D
1A4-T	4K	1-V	4G	6AH5-G	6AP	6SE7-GT	8N	12A5	7F
1A5-G	6X	1V1	4A	6AH7-GT	8BE	6SF5	6AB	12A6	7AC
1A6-GT	6L	1Y1	4A	6AL6-G	6AM	6SF7	7AZ	12A7	7K
1A6S	6L	1Z1	4A	6A7	7C	6SG7	8BC	12A8-GT	8A
1A7-G	7Z	2	4A	6A7-M	8A	6SH7	8BK	12AH7-GT	8BE
1B1	4A	2A3	4D	6A7-S	7C	6SJ7	8N	12B7	8V
1B4	4K	2A3-H	4Q	6A8	8A	6SK7	8N	12B8-GT	8T
1B4-P	4M	2A4-G	5S	6B4-G	5S	6SL7-GT	8BD	12C8	8E
1B5/25S	6M	2A5	6B	6B5	6AS	6SN7-GT	8BD	12E5-GT	6Q
1B7-G	7Z	2A6	6G	6B6-G	7V	6SQ7	8Q	12F5-GT	5M
1C1	4A	2A7	7C	6B7	7D	6SR7	8Q	12G7	7V
1C5-G	6X	2B6	7J	6B8	8E	6SS7	8N	12H6	7Q
1C6	6L	2B7	7D	6C4	6BG	6ST7	8Q	12J5-GT	6Q
1C7-G	7Z	2E5	6R	6C5	6Q	6T5	6R	12J7-GT	7R
1D1	4A	2G5	6R	6C5-G	6Q	6T7-G	7V	12K7-GT	7R
1D5-GP	5Y	2S/4S	5D	6C6	6F	6U5/6G5	6R	12K8	8K
1D5-GT	5R	2V3-G	4Y	6C7	7G	6U6-GT	7AC	12Q7-GT	7V
1D7-G	7Z	2W3	4X	6C8-G	8G	6U7-G	7R	12SA7	8R
1D8-GT	8AJ	2X2/879	4AB	6D5	6Q	6V6	7AC	12SA7-GT	8AD
1E1	4A	2Y2	4AB	6D6	6F	6V7-G	7V	12SC7	8S
1E4-G	5S	2Y3	4C	6D7	7H	6W5-G	6S	12SF5	6AB
1E5-G	5R	2Y4	5D	6D8-G	8A	6W6-GT	7AC	12SF7	7AZ
1E5-GP	5Y	2Z2	4B	6E5	6R	6W7-G	7R	12SG7	8BC
1E7-G	8C	3	4A	6E6	7B	6X5	6S	12SH7	8BK
1F1	4A	3A4	7BB	6E7	7H	6Y3	4AC	12SJ7	8N
1F4	5K	3A5	7BC	6F5	5M	6Y5	6J	12SK7	8N
1F5-G	6X	3A8-GT	8AS	6F5-G	5M	6Y6-G	7AC	12SL7-GT	8BD
1F6	6W	3C5-GT	7AQ	6F6	7S	6Y7-G	8B	12SN7-GT	8BD
1F7-G	7AD	3LE4	X-14	6F7	7E	6Z3	4G	12SQ7	8Q
1F7-GH	7AD	3LF4	6BB	6F7-S	7E	6Z4	5D	12SR7	8Q
1F7-GV	7AD	3Q4	7BA	6F8-G	8G	6Z5	6K	12Z3	4Q
1G1	4A	3Q5-GT	7AP	6G5	6R	6Z6	7Q	12Z5	6K
1G4-G	5S	3S4	7BA	6G6-G	7S	6Z7-G	8B	14	5E
1G5-G	6X	4	4A	6G7	7N	6ZY5-G	6S	14A4	5AC
1G6-G	7AB	4A6-G	8L	6G7S	7N	7	4A	14A5	6AA
1H4-G	5S	4S	5D	6H4-GT	5AF	7A4	5AC	14A7	8V
1H5-G	5Z	5	4A	6H5	6R	7A5	6AA	14B6	8W
1H6-G	7AA	5T4	5T	6H6	7Q	7A6	7AJ	14B8	8X
1J1	4A	5U4-G	5T	6H7	7P	7A7-LM	8V	14C5	6AA
1J5-G	6X	5V4-G	5L	6H7-S	7P	7A8	8U	14C7	8V
1J6-G	7AB	5W4	5T	6H8	8E	7B4	5AC	14E6	8W
1K1	4A	5X3	4C	6J5	6Q	7B5	6AE	14F7	8AC
1L1	4T	5X4-G	5Q	6J6	7BF	7B6	8W	14H7	8V
1L4	X-39	5Y3-G	5T	6J7	7R	7B7	8V	14J7	8AR
1LA4	5AD	5Y4-G	5Q	6J7-G	7R	7B8	8X	14N7	8AC
1LA6	7AK	5Z3	4C	6J7-GT	7R	7C5	6AA	14Q7	8AL
1LB4	5AD	5Z4	5L	6J8-G	8H	7C6	8W	14R7	8AE
1LB6	8AX	6	4A	6K5-G	5U	7C7	8V	14S7	8BL
1LC5	7AO	6A3	4D	6K6-G	7S	7E6	8W	14W7	8BJ
1LC6	7AK	6A4/LA	5B	6K7	7R	7E7	8AE	14Y4	5AB
1LD5	6AX	6A5-G	6T	6K8	8K	7F7	8AC	14Z3	4G
1LE3	4AA	6A6	7B	6L5-G	6Q	7G7	8V	15	5F
1LH4	5AG	6AB5	6R	6L6	7AC	7H7	8V	17	5A
1LN5	7AO	6AB6	7AU	6L7	7T	7J7	8AR	18	6B
1N1	4T	6AB7/1853	8N	6N5	6R	7K7	8BF	19	6C
1N5-G	5Y	6AC5-G	6Q	6N6-G	7AU	7L7	8V	20	4D

TABLE I—TUBE BASE LIST (Continued)

Tube Type	Base	Tube Type	Base	Tube Type	Base	Tube Type	Base	Tube Type	Base
22	4K	49	5-C	90	6N	958	X-8	D-½	4B
24A	5E	49A2	X-4	91	6N	959	X-7	D-1	4C
24S	5E	49B2	X-4	92	6N	985	5D	DE	4D
25	6M	50	4D	95	6B	986	4C	E	4D
25A6	7S	50A5	6AA	96	4G	1201	X-26	G	4D
25A7-G	8F	50C6-G	7AC	98	5D	1203	X-27	GA	5B
25AC5-GT	6Q	50L6-GT	7AC	112A	4D	1204	X-28	G-2	5D
25B5	6D	50Y6-GT	7Q	117L7-GT	8AO	1221	6F	G-2S	5D
25B6-G	7S	50Z6-G	7Q	117M7-GT	8AO	1223	7R	G-4	5D
25B8-GT	8T	50Z7-G	8AN	117N7-GT	8AV	1231	8V	G-4S	5D
25C6-G	7AC	51	5E	117P7-GT	8AV	1232	8V	G-84	5D
25D8-GT	8AF	52	5C	117Z6-GT	7Q	1284	X-29	H	4D
25L6	7AC	53	7B	165R	4A	1291	X-30	HY-114B	X-33
25N6-G	7W	55	6Q	165R4	X-3	1293	X-31	HY-615B	X-34
25S	6M	56	5A	165R8	X-3	1294	X-27	K-24	5E
25X6-GT	7Q	56AS	5A	181	4D	1299	6BB	K-27	5A
25Y4-GT	5AA	56S	5A	182A	4D	1602	4D	KR-1	4G
25Y5	6E	57	6F	182B	4D	1603	6F	KR-2	4G
25Z3	4G	57AS	6F	183/483	4D	1609	5K	KR-5	5B
25Z4	5AA	57S	6F	185R	4A	1612	7T	KR-20	6N
25Z5	6E	58	6F	185R4	X-3	1613	7S	KR-22	6N
25Z6	7Q	58AS	6F	185R8	X-3	1614	7AC	KR-25	6B
26	4D	58S	6F	210T	4D	1620	7R	KR-28	5D
27	5A	59	7A	213	4C	1621	7S	KR-31	4G
27HM	5A	59A	7A	213B	4C	1622	7AC	KR-98	5D
27S	5A	59S	7A	216	4B	1625	X-16	KR-7184	X-38
29	6N	64	5E	216B	4B	1626	6Q	LA	5B
30	4D	65	5E	257	5B	1629	X-13	P-861	5D
31	4D	67	5A	264	4D	1631	7AC	PZ	5B
32	4K	68	5E	291	5G	1632	7AC	PZH	5B
32L7-GT	8Z	69	5E	293	5G	1633	8BD	RA-1	4Q
33	5K	70	6N	295	5G	1634	8S	RE-1	4C
34	4M	70A7-GT	8AB	482A	4D	1635	X-22	RE-2	4B
35	5E	70L7-GT	8AA	482B	4D	1642	X-17	RK-19	X-1
35A5-LT	6AA	71A	4D	483	4D	1851	7R	RK-21	4AB
35L6-GT	7AC	75	6G	484	5A	1852	8N	RK-22	X-1
35Y4	5AL	75M	7V	485	5A	1853	8N	RK-24	4D
35Z3-LT	4Z	75S	6G	486	X-9	9001	X-18	RK-33	X-17
35Z4-GT	5AA	76	5A	585	4D	9002	X-19	RK-34	X-37
35Z5-GT	6AD	77	6F	586	4D	9003	X-18	RK-47	5J
35Z6-G	7Q	77M	7R	801	4D	9004	X-23	RK-62	4D
36	5E	78	6F	803	5J	9005	X-24	SO-1	4Q
37	5A	78S	6F	804	5J	A (5)	5H	SO-2	4D
38	5F	79	6H	807	X-11	A (6)	6N	V-99	4E
39/44	5F	80	4C	837	X-15	A-22	4D	VR-50	4W
40	4D	81	4B	840	5J	A-26	4D	VR-75-30	X-12
40Z5	6AD	82	4C	841	4D	A-28	4D	VR-90-30	4W
41	6B	82V	4L	842	4D	A-30	4Q	VR-105-30	X-12
41M	7S	83	4C	843	5A	A-32	4Q	VR-150-30	X-12
42	6B	83V	4L	864	4D	A-40	4Q	WE-215A	4D
42A2	X-4	84/6Z4	5D	865	X-2	A-48	4Q	WE-231D	4D
42B2	X-4	85	6G	874	4S	AC-22	5E	WE-257A	X-20
43	6B	85AS	6G	878	4P	AD	4G	WE-300A	4D
43-MG	7S	85L7	8AB	879	4AB	AF	4C	WE-300B	4D
44	5F	85M	7V	884	6Q	AG	4C	WE-306A	X-21
45	4D	85S	6G	885	5A	AX	4Q	WE-307A	5J
45Z3	5AM	86M	6Q	950	5K	B	4E	WE-350A	X-11
45Z5-GT	6AD	87S	6F	951	4K	BA	4J	WE-713A	8BK
46	5C	88	4C	954	X-5	BH	4J	WE-717A	X-35
46A1	X-10	88S	6F	955	X-6	BR	4H	X-99	4D
46B1	X-10	89	6F	956	X-5	BX	4D	XXD	8AC
47	5B	89RS	7N	957	X-8	CK-1005	X-32	XXL	5AC
48	6A								

TABLE II—TUBE BASE LIST

ARMY-NAVY PREFERRED TYPES

Tube Type	Base	Tube Type	Base	Tube Type	Base	Tube Type	Base
1A3	5AP	5Y3-GT	5T	6SG7	8BC	12SG7-GT	8BC
1L4	6AR	6AL5	X-40	6SH7	8BK	12SH7	8BK
1LC6	7AK	6AC7/1852	8N	6SJ7	8N	12SJ7	8N
1LE3	4AA	6AG5	X-36	6SK7	8N	12SK7-GT	8N
1LH4	5AD	6AG7	8Y	6SL7-GT	8BD	12SL7-GT	8BD
1LN5	7AO	6AK5	X-36	6SN7-GT	8BD	12SN7-GT	8BD
1R5	7AT	6AQ6	X-42	6SQ7	8Q	12SQ7	8Q
1S5	6AU	6C4	6BG	6SR7	8Q	12SR7	8Q
1T4	6AR	6E5	6R	6V6-GT/G	7AC	25L6-GT/G	7AC
2C22	X-34	6G6-G	7S	6Y6-G	7AC	25Z6-GT/G	7Q
2C26	X-43	6H6	7Q	6X5-GT/G	6S	28D7	X-45
3A4	7BB	6J4	X-44	7E5/1201	X-26	559	X-41
3A5	7BC	6J5	6Q	7W7	8BJ	1005	X-32
3B7/1291	X-30	6J6	7BF	12A6	7AC	1629	X-13
3D6/1299	6BB	6L6-GA	7AC	12H6	7Q	9001	X-18
3S4	7BA	6N7-GT/G	8B	12J5-GT	6Q	9002	X-19
5U4-G	5T	6SA7	8R	12SA7	8R	9003	X-18
						9006	X-46

Listed as of 15 February 1944. This list includes all receiving types in the Army-Navy preferred list, grouped on this one page for quick reference. Most of these types are also included in the Tube Base List (Miscellaneous Tubes).

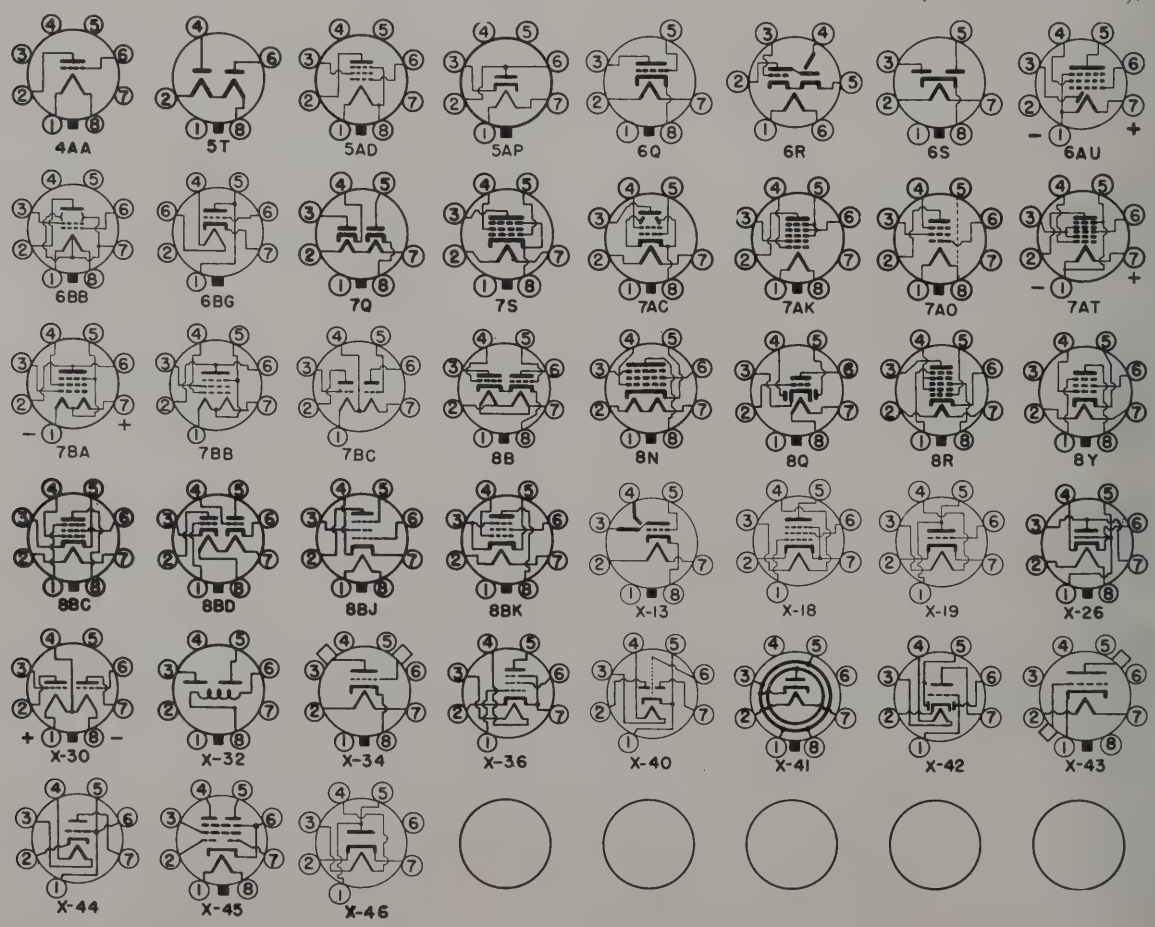


Figure 6—Tube Base Connections Army-Navy Preferred Types

Weston

Model 772

WARNING

HIGH VOLTAGE

is used in the operation of this equipment.

DEATH ON CONTACT

may result if personnel fail to observe safety precautions.

CAUTION: HIGH VOLTAGES ARE DANGEROUS!

Use the utmost care to avoid accidental contact with, or even close proximity to high voltage points. Use one hand only! Keep the fingers and all other parts of the body as far away as conveniently possible from any high potential point. If at all possible, when making other a-c or d-c high voltage measurements, attach the test leads to the circuit to be measured with the power turned off. After completing the measurement, turn the power off again and make sure any capacitators in the circuit, are discharged before removing the test leads.

FIRST AID TREATMENT FOR ELECTRIC SHOCK

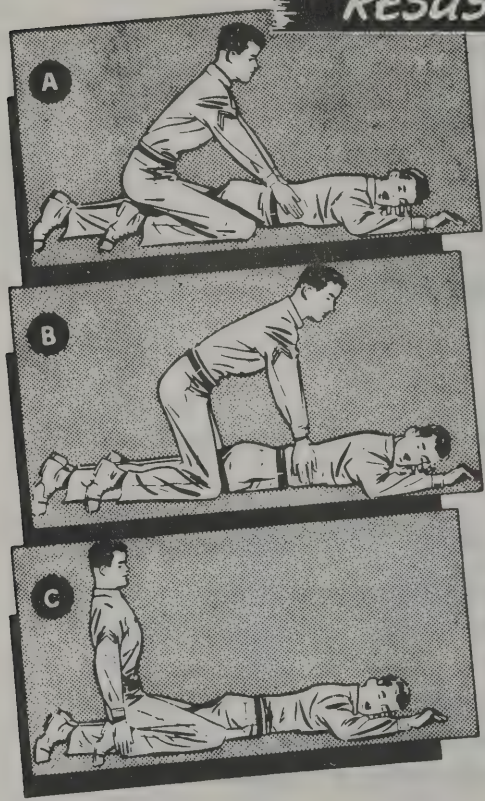
I. FREE THE VICTIM FROM THE CIRCUIT IMMEDIATELY.

Shut off the current. If this is not immediately possible, use a dry nonconductor (rubber gloves, rope, board) to move either the victim or the wire. Avoid contact with the victim. If necessary to cut a live wire, use an axe with a dry wooden handle. Beware of the resulting flash.

II. ATTEND INSTANTLY TO THE VICTIM'S BREATHING.

Begin resuscitation at once on the spot. Do not stop to loosen the victim's clothing. Every moment counts. Keep the patient warm. Wrap him in any covering available. Send for a doctor. Remove false teeth or other obstructions from the victim's mouth.

RESUSCITATION



POSITION

1. Lay the victim on his belly, one arm extended directly overhead, the other arm bent at the elbow, the face turned outward and resting on hand or forearm, so that the nose and mouth are free for breathing (fig. A).

2. Straddle the patient's thighs, or one leg, with your knees placed far enough from his hip bones to allow you to assume the position shown in figure A.

3. Place your hands, with thumbs and fingers in a natural position, so that your palms are on the small of his back, and your little fingers just touch his lowest ribs (fig. A).

FIRST MOVEMENT

4. With arms held straight, swing forward slowly, so that the weight of your body is gradually brought to bear upon the victim. Your shoulders should be directly over the heels of your hands at the end of the forward swing (fig. B) Do not bend your elbows. The first movement should take about 2 seconds.

SECOND MOVEMENT

5. Now immediately swing backward, to remove the pressure completely (fig. C).

6. After 2 seconds, swing forward again. Repeat this pressure-and-release cycle 12 to 15 times a minute. A complete cycle should require 4 or 5 seconds.

CONTINUED TREATMENT

7. Continue treatment until breathing is restored or until there is no hope of the victim's recovery. Do not give up easily. Remember that at times the process must be kept up for hours.

8. During artificial respiration, have someone loosen the victim's clothing. Wrap the victim warmly; apply hot bricks, stones, etc. Do not give the victim liquids until he is fully conscious. If the victim must be moved, keep up treatment while he is being moved.

9. At the first sign of breathing, withhold artificial respiration. If natural breathing does not continue, immediately resume artificial respiration.

10. If operators must be changed, the relief operator kneels behind the person giving artificial respiration. The relief takes the operator's place as the original operator releases the pressure.

11. Do not allow the revived patient to sit or stand. Keep him quiet. Give hot coffee or tea, or other internal stimulants.

HOLD RESUSCITATION DRILLS REGULARLY

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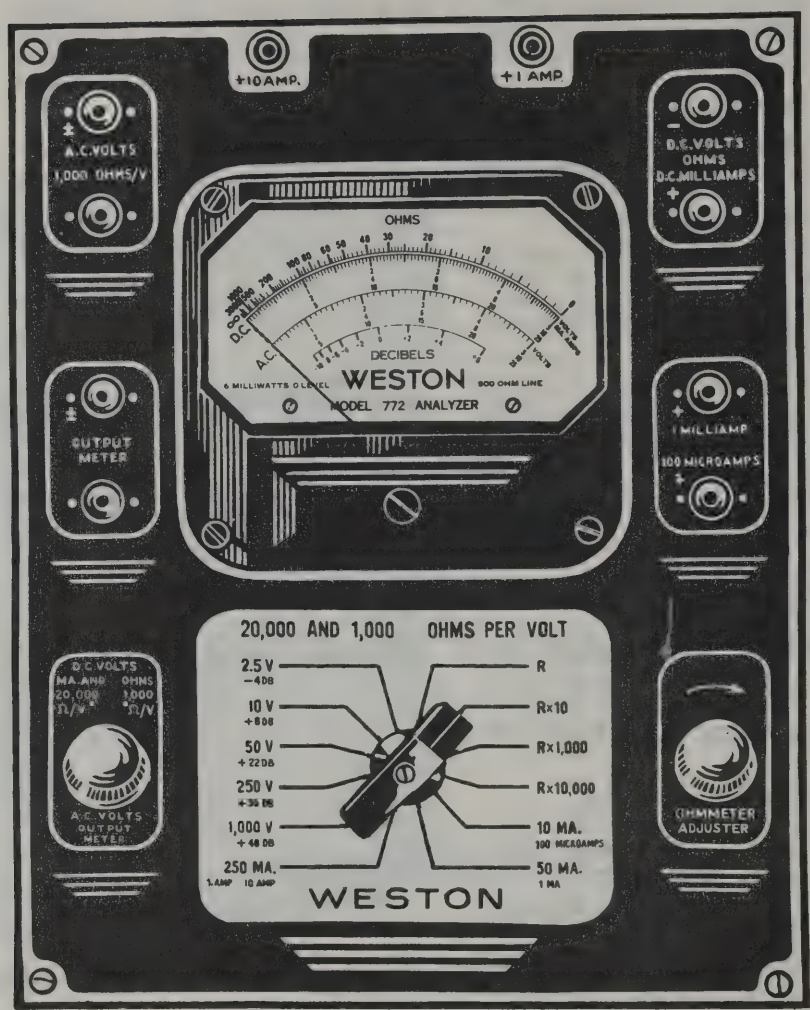


Figure 1—Model 772, Type 6—Panel View

Instructions for Model 772, Type 6 Analyzer

I. DESCRIPTION OF THE ANALYZER

1.1 — General. This model 772 analyzer has been specifically designed to place in the hands of the service man an ultra sensitive and complete analyzer for all types of service work. In designing this equipment every possible extra cost has been eliminated and the design kept as clean and free as possible from gadgets and other unnecessary frills. All the equipment with the exception of the batteries for the ohmmeter is mounted directly on the metal panel, this panel mounting directly in the instrument carrying case. The complete analyzer is of rugged construction and with reasonable care should give many years of accurate service.

1.2 — Instrument. The heart of any piece of test equipment is the electrical measuring instrument. If this particular part is not carefully and accurately designed and constructed no matter how many other parts are used in the equipment the device cannot give accurate readings. The instrument in the Model 772 is of the 4¼" type having a movement considerably larger than that used in the 301 size meters. The meter is purposely designed with a large open face so that light will be admitted to the scale from all sides giving maximum visibility of the scale. In addition a large scale plate is used with a long pointer length so that maximum scale arc length is available. The instrument is equipped with a tubular type pointer having an extended knife edge covering all of the arcs. Considerable work has been done on the design of the scale to increase ease of readability and to make possible a maximum accuracy. The d.c. scale which is the most important of the voltage and current measurements consists of a 100 line or division arc. A large instrument of this type makes possible such a finely divided scale. Directly above this d.c. scale appears an ohm scale extending from 0 to 3000. This arc has been carefully divided to give accurate ohm readings. The a.c. and db scales have been calibrated in red to differentiate them from the d.c. Note that all a.c. voltages, no matter what range is used, are read on a single arc. Painstaking research in the laboratory has resulted in a newly developed rectifier and associated circuit which makes possible the measuring of a low voltage on the 2.5 range and a higher voltage on the 10-50-250 or 1000 range with equal accuracy using a single arc.

1.3 — Panel. The panel for this instrument has been carefully worked out to provide simplicity of operation along with modern appearance. Brief instructions for each of the controls are etched directly in the panel so that once the general operation of the tester is understood no further instructions need be referred to. The molded bakelite pin jacks used in this model are of a new and highly efficient design. When working with sensitivities of 20,000 ohms per volt, leakage paths in the mechanical structure of the tester must be kept at a minimum. It is easy to see that on the 1000 volt d.c. range 20 megohms of adjusted resistance is required. If, therefore, a shunt leakage path of even 200 megohms should appear across any of the pin jacks then a 10% error in reading might occur. It is, therefore, vital that these jacks should be of the best molded bakelite and they have been designed with a very long leakage path. The phosphor bronze clip in the jack is mounted from the back end and, therefore, the leakage path across the jack is from the panel all the way down to the base of the jack at the back to the insert or approximately ½". Ten active jacks appear on the panel, the two above the meter being available for the 10 and 1 amp. range and for mounting the type 666, selector block. The use of this block as a part of the analyzer equipment will be covered later on in the instructions. The two upper right-hand jacks labelled d.c. volts, ohms, and d.c. milliamperes are used for all of the d.c. volt ranges, all of the ohm ranges and for all of the d.c. milliampere ranges appearing on the switch. There are available then from these jacks the following:

D.C. Volts 20,000 Ohms per Volt or 1,000 Ohms per Volt	Ohms	D.C. Milliamperes
2.5	0 — 3000	10
10	0 — 30,000	50
50	0 — 3 megohms	250
250	0 — 30 megohms	
1000		

1.31—All d.c. volt ranges are available at two sensitivities. This dual sensitivity arrangement is of considerable help, where data taken on 1,000 ohm per volt instruments has been listed. The two sensitivities are available from the small 3-position functional switch to the left of the range switch. This control is equipped with a small bakelite knob having two index dots spaced 180° apart. For 20,000 ohm per volt sensitivity, index the upper dot on the knob to the left-hand position or, in other words, rotate the control to the extreme counterclockwise position. For 1000 ohms per volt the upper dot should be indexed to the right or to the extreme clockwise position. For a.c. volts, this control is indexed with the lower dot in the center position. Readings on the 20,000 ohms per volt sensitivity are of considerable advantage on high resistance circuits as the maximum current drain is 50 microamperes. This makes possible far more accurate readings of grid bias, screen and plate voltage in all types of equipment where high resistance circuits are used.

1.32—OHMS. Four ohmmeter ranges provide accurate resistance measurements from ¼ ohm to 30 megohms. Before taking resistance readings, be sure the 3-position functional switch is set to either the left-hand or right-hand index position. Ohmmeter readings cannot be taken when this switch is indexed for a.c. volts. It can, however, be in either of the two ohmmeter positions without any effect on the ohmmeter accuracy. Plug one end of the test leads into the jacks marked D.C. Volts-Ohms-D.C. Milliamps and touch the free ends to the circuit being measured. For readings from ¼ ohm to 100 ohms, the Selector Switch should be in the R position. For readings between 100 and 1,000 ohms set the Switch to R x 10. Readings from 1,000 ohms to 1 megohm are taken with

the switch set to R x 1,000 and for measurements up to 30 megohms the R x 10,000 range is used. Before making resistance measurements and when changing ranges the operator should short the test leads and rotate the OHMMETER ADJUSTER until the pointer indicates exactly full scale. The accuracy of the readings obtained depends largely upon the care with which this setting is made. The d.c. battery potential on the three lower ohm ranges is 1.5 volts. On the R x 10,000 range 15 volts is used. This means that the ohm ranges can be used on all types of low voltage condensers and other low voltage equipment to measure leakage, resistance, etc. When the ohmmeter ranges are used it must be kept in mind that the "+" pin jack is connected to the negative end of the internal ohmmeter battery. This means that when testing electrolytic condensers for leakage, the negative side of the condenser should be connected to the panel jack marked +. This information is important to observe correct polarity and to obtain the resistance of the condenser under correct polarity conditions.

1.33—AMPERES, MILLIAMPERES AND MICROAMPERES. Eight d.c current ranges are available. To take current readings, plug the test leads into the jacks marked D.C. VOLTS-OHMS-D.C. MILLIAMPS and set the switch to the 10, 50 or 250 milliampere range as required. If readings below these values are needed, the — test lead should be left in its jack but the + lead should be plugged into the 1 MILLIAMP or 100 MICROAMPS jack. The circuit should be checked before connecting the meter into these last two ranges. This is especially true on the 100 microampere range where the instrument is sensitive enough to read all kinds of leakage and shunt currents. When taking readings on the 1 MILLIAMP or 100 MICROAMPS ranges, the range switch should be set to the 1 MILLIAMP or 100 MICROAMP positions respectively. If readings above 250 MILLIAMPS are required, set the range switch to 250 MILLIAMPS-1 AMPERE-10 AMPERES position and move the + lead to the 10 amp. or 1 amp. pin jack. Note that for all d.c. measurements the functional switch to the left of the range switch should always be in one of the D.C. VOLTS-MILLIAMPS or OHMS positions. Readings of 50 microamperes full scale may be taken when this extreme sensitivity is required. This is accomplished by plugging the test leads into the D.C. VOLTS-OHMS-D.C. MILLIAMPS jacks and setting the rotary switch to the 2.5 volt position. The instrument is now converted into a 50 microampere high resistance microammeter and readings may be taken directly and accurately in terms of 50 microamps full scale. Some resistance is still in this circuit due to the 2.5 volt range but this is advantageous as it tends to protect the meter from heavy overloads. Note that when taking readings on this 50 microampere range, the first full division on the scale is .5 microampere.

THE 10 AMPERE, 1 AMPERE, 1 MIL. AND 100 MICROAMPERE RANGES HAVE PURPOSELY BEEN BROUGHT OUT TO PIN JACKS SO THAT WHEN CHANGING POSITIONS ON THE ROTARY SWITCH THE METER WILL NOT BE SUBJECT TO SEVERE OVERLOADS IN PASSING THROUGH THESE RANGES.

1.34—A.C. VOLTS. Five a.c. volt ranges are available for the same full scale values as the d.c. ranges. All of these a.c. ranges operate at 1000 ohms per volts. This sensitivity is entirely sufficient for the most sensitive a.c. readings and is far preferred to higher sensitivity as much more accurate readings can be obtained. When the current density in an instrument rectifier gets far below a 1 mil. or 1000 ohm per volt value, its temperature and resistance characteristics become very critical and therefore, standard 1000 ohms per volt a.c. ranges are supplied. A new rectifier and associated circuit permits a single a.c. arc for all voltage ranges and has decreased the error due to temperature to 2% from 40° F. to 114° F. Note that when taking readings on a.c. or across the output meter jacks, the 3-position functional switch in the lower left-hand corner must be indexed to the A.C. VOLTS-OUTPUT METER position. Accurate readings can be taken on the a.c. ranges over a wide band of frequencies extending over the complete audio spectrum. The meter has a substantially flat frequency characteristic up to 7000 cycles and at this point starts to drop off at approximately .5% per thousand cycles. This slight error is generally considered negligible as it is far smaller than the errors introduced by even the best of transformers and other such equipment. NOTE THAT ALL A.C. READINGS ARE TAKEN ON A SINGLE ARC LOCATED BETWEEN THE D.C. AND DB. SCALE.

1.35—DECIBELS. Total db range from —14 to +54 is available in 5 steps. The zero power level is based on a 6 mw. level in a 500-ohm line. To take readings of decibels place the test leads in the a.c. volt jacks and index the functional switch in the lower left-hand corner in the A.C. VOLTS-OUTPUT METER position. Set the selector switch to the power level desired and take readings on the decibel arc, adding or subtracting to the indication the figure engraved on the panel directly under the voltage range selected. For example: If the selector switch is set on 50 V and the meter reads —2 db, add +22, the figure engraved under the 50 Volt position, and the power level is +20 db.

1.36—OUTPUT METER. The output meter jacks should be used only when d.c. must be kept out of the circuit. A blocking condenser of .2 microfarad is connected in series with these jacks protecting the meter from d.c. current. It is not advisable to take actual volt readings on these jacks except on the higher ranges. While the readings on each of the volt switch positions will be approximately the same as the readings appearing across the a.c. volt jacks, the reactance of the condenser will add vectorially to the resistors in the meter circuit and therefore will cause a slight drop in instrument reading. Likewise reactance of the condenser will vary with frequency and therefore accurate readings of a.c. volts should not be made using these jacks but should be taken with the leads connected to the a.c. volt jacks.

1.4 — Batteries. This tester requires 3 batteries. A 1.5 volt flashlight cell (Burgess No. 2 or Eveready No. 950 unicell) is used for the R, R x 10, and R x 1000 ranges. This cell should be replaced when it is no longer possible to bring the pointer to top scale or zero mark on these three ranges. Two 7.5 volt batteries (Burgess No. 5540 or equivalent) are used only with the R x 10000 range. These cells should be changed when it is no longer possible to bring the pointer to zero mark on this range. To replace the unicell, place the thumb over the positive battery end of the clamp pressing toward the battery, and pull up

the wire ring clip. Replace the unicell and refasten the ring clip by placing the open end over the two projections at the negative end and snap the closed end over the thumb clamp at the positive end.

When replacing the two 7.5 volt batteries, the connections are as follows:

Connect the two in series by connecting the black lead on one to the + terminal on the other. The remaining black lead should then be connected to the binding post on the negative end of the 1.5 volt battery clamp. The free red lead from the tester panel should then be connected to the remaining + post to obtain 15 volts.

1.5 — Case. This tester is equipped with a sturdily constructed wooden case which will stand considerable abuse. The wood is finished in a natural color, no stain being used so that scratches incurred during normal service will not show to any appreciable extent. However, should the case become marred it may easily be touched up by using clear lacquer on the section affected or by rubbing up with any good furniture polish.

1.6 — Test Leads. One standard pair of test leads is supplied with this instrument. These may be used at all times in conjunction with the tester proper or with the Model 666 Selector Block. If the leads are lost or broken, they may be replaced by ordering Test Leads Nos. 70033 and 70034.

1.7 — Instruction Book One copy of this instruction book is supplied with each tester. In the latter section of the book abundant data is available in regard to the operation of the tester as well as some information on circuit analysis or receiver or amplifier trouble shooting. This book should be kept inside of the tester when it is being transported so that it will be available for immediate use at any time, should questions arise as to the most efficient operation of the tester.

Test Procedure

II. SELECTION OF RANGES

2.1 — D. C. Volts

a. Plug red test lead in the + jack marked D.C. VOLTS-OHMS-MA. Plug black test lead in — jack.

b. Set the 3-position functional switch to either the 1000 ohm per volt or the 20,000 ohm per volt position, depending upon the voltmeter sensitivity desired.

c. Rotate range switch to any one of 5 ranges required.

d. Take reading on black d.c. 100 line arc using figuring that goes with this arc. Multiply by 1, 10, or 100 in accord with the switch range being used.

NOTE: All ranges are available at 1,000 and 20,000 ohms per volt. The current that the voltmeter draws may be calculated on the basis of 1 milliamp or 50 microamperes respectively.

e. The resistance of the high sensitivity voltage ranges are as follows:

2.5	volt range —	50,000 ohms
10	volt range —	200,000 ohms
50	volt range —	1 megohm
250	volt range —	5 megohms
1000	volt range —	20 megohms

2.2 — Ohms

a. Plug test leads in D.C. VOLTS-OHMS-MA. jacks.

b. Set functional switch in either left or right-hand ohm position.

c. Rotate range switch to ohm range desired.

R range	0 — 3,000 ohms
R x 10	0 — 30,000 ohms
R x 1000	0 to 3 megohms
R x 10,000	0 to 30 megohms

d. Short test leads and set pointer to top mark by rotating OHMMETER ADJUSTER.

e. Take ohm readings on top arc using multiplying factor in accord with the switch position.

2.3 — D. C. Current

a. Plug leads in D.C. VOLTS-OHMS-MA. jacks.

b. Set functional switch to either left or right-hand MA. position.

c. Rotate range switch to milliampere range desired. (250, 50 or 10 MA.)

d. Take readings on 100 line d.c. arc.

For 1 milliampere or 100 microamperes:

e. Leave black lead in — jack.

f. Plug red lead in + 1 MA. or + 100 MICROAMPERES jack as required.

g. Set range switch in 10MA—1MA—.1MA position.

h. Take reading on 100 line d.c. arc.

For 50 microamperes:

i. Set up tester for d.c. volts.

j. Rotate range switch to 2.5 volt position.

k. Take readings of 50 microamperes full scale on d.c. arc.

For 10 Amp. or 1 Amp.:

l. Leave black lead in — pin jack.

m. Set range switch to 250MA—1Amp.—10Amp. position.

n. Plug red lead in + 10 Amp or + 1 Amp pin jacks as required.

o. Take reading on 100 line d.c. arc.

2.4 — A. C. Volts

a. Plug leads into A.C. VOLT jacks.

b. Set functional switch to the center position marked A.C. VOLTS-OUTPUT METER.

c. Rotate range switch to any one of the five volt ranges.

d. Read on red arc for all volt ranges.

2.5 — Output Meter

a. Plug test leads in OUTPUT METER jacks.

b. Set functional switch to A.C. VOLTS-OUTPUT METER position.

c. Rotate range switch to any one of the five volt ranges desired.

d. Readings will be relative as condenser in circuit will cause error on low ranges.

NOTE: A .2 mfd. series condenser is built in the analyzer protecting the instrument from d.c. Do not use output jacks on d.c. circuits having potentials much over 400 volts, as this is the working voltage of the condenser.

2.6—Decibels

a. Plug leads into A.C. VOLT jacks.

b. Set functional switch to A.C. VOLTS-OUTPUT METER position.

c. Rotate range switch to any one of the five volt positions.

d. Read on the red decibel scale.

e. Subtract or add to the meter indication the figure engraved on the panel just below the volt range selected.

III. MODEL 772 ANALYZER WITH MODEL 666 SOCKET SELECTOR

3.1 — This tester has been designed for use as an analyzer using Weston's well known method of socket selector analysis. The 10 amp. and 1 amp. pin jacks directly above the instrument are correctly spaced to fit the pins on the base of the Model 666 Selector block. By fitting the block in position and using the small jumper leads supplied with the block, voltage, current, resistance, decibels and output readings can be taken rapidly and accurately on any type of tube base irregardless of its pin arrangement and electrode position. When the selector unit is used there will be no requirements necessitating the use of the 10 amp. and 1 amp. current ranges, and hence the placing of the selector block on these pin jacks will not limit the use of the two high current ranges. The tester case has been provided with a compartment at the top for carrying this block and its set of skirted adapters. These adapters carry over the tube pin numbering on each type of base in accord with the standard Weston and RMA. tube base charts which are supplied with the socket selector unit. The adapters fit into the holes in the wooden block mounted in the bottom of this compartment.

3.2 — To obtain readings set the socket selector block in position using the two above mentioned jacks, as shown in figure 2. Select the adapter that has the base corresponding to that of the tube under test. These adapters are color coded so that they can be picked out rapidly.

4 prong—red
5 prong—green
6 prong—blue
small 7 prong—light brown
large 7 prong—black
8 prong—orange
8 prong loktal—dark brown
7 prong miniature—black

Place the skirted adapter in the selector block and the plug adapter on the end of the analyzer plug. Remove the tube on which measurements are to be taken from the chassis and insert plug. Place the tube in the block socket. If the operator is familiar with the tube electrode positions, measurements of current, voltage or resistance on any electrode may be rapidly made by connecting the jumper cables

View Showing Model 666 Socket Selector Block Mounted on Model 772 Analyzer

Figure 2

from the block jacks to any of the tester jacks. IF THE TUBE ELECTRODE POSITIONS ARE NOT KNOWN, REFERENCE SHOULD BE MADE TO THE TUBE BASE DATA CONNECTION CHART, A COPY OF WHICH IS ENCLOSED. These charts tie any tube base to the numbers on the selector block.

THIS METHOD IS ESPECIALLY VALUABLE AS A CURRENT JACK IN EACH CIRCUIT ALLOWS INSERTION OF ANY MILLIAMPERE RANGE IN ANY ELECTRODE CIRCUIT. CURRENT READINGS ARE VITAL AS THEY TELL JUST WHAT THE TUBES ARE DRAWING.

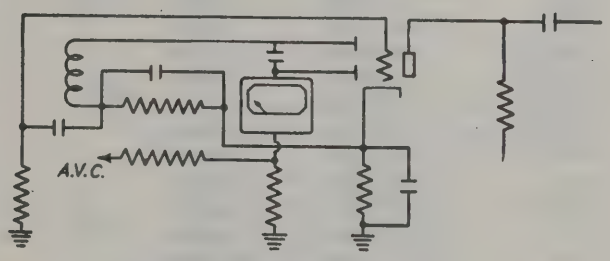
Convenient point to point resistance checks are also valuable and can be most easily made across the readily available selector block jacks. Note the picture of the analyzer set-up for measurements of plate current on a type 6-A-8 tube.

IV. UNUSUAL MEASUREMENTS MADE WITH THE MODEL 772 ANALYZER

4.1 — Measurements of grid, plate, screen and cathode voltage can be made with far better accuracy on a 20,000 ohm per volt analyzer than on those with lower sensitivity. The high resistances used in these circuits will cause large voltage drops when an instrument of low sensitivity is inserted in the circuit. Power detectors using high resistance cathode circuits are difficult to measure for exact bias as the current in these circuits is quite small. By using the 50 volt range on the Model 772 such voltage can be accurately measured in the vicinity of 20 volts which is often required for power detection. When making a measurement of this type only 20 microamperes would be drawn by the meter,

this being a fraction of the current in the cathode circuit of these tubes. In general, for making all types of voltage measurement, the instrument can be handled like any other voltmeter but if there is any doubt in the serviceman's mind as to the greatly increased value of this sensitivity, an easy test can be made by taking measurements on a 250,000 ohm plate circuit of the resistance coupled to it. A comparison is shown below, giving the readings that would be obtained on this modern analyzer as against the old 125 ohm per volt and later 1000 ohm per volt types.

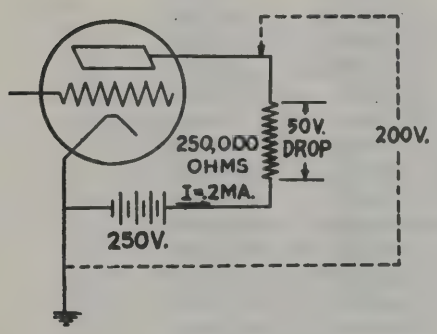
4.2 — Measurements of rectified diode current are of vital importance in making tests of a.v.c and diode detector receivers. Diode currents seldom run over 100 microamperes except on very strong signals and, therefore, measurements as low as 1 microampere will be very valuable. Diagrams showing the method of taking these measurements in a typical diode detector and a.v.c. circuit is shown in figure 3. If the one megohm resistor is used in the a.v.c. circuit, the a.v.c. bias can be read directly on the instrument by converting each reading in microamperes directly to volts, as one microampere through a megohm will give a reading of one volt. Note that the 100 microampere range is used for some readings as its resistance is quite low i.e., in the order of 1250 ohms. For more sensitive readings the 2.5 volt position can be used for reading 50 microamperes, but the 50,000 ohms in this circuit will sometimes upset the a.v.c. and detector circuits. With either of these ranges note that accurate readings can be taken down to .5 microampere.



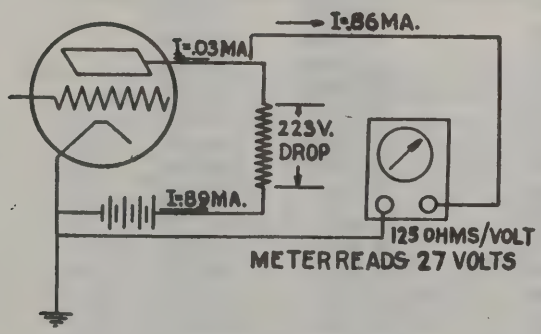
Meter in A. V. C. Diode Circuit to Check A. V. C. Action

Figure 3

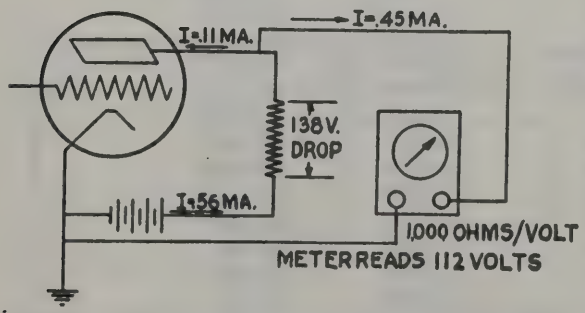
EFFECT OF DIFFERENT METER SENSITIVITIES ON A TYPICAL RESISTANCE COUPLED PLATE CIRCUIT



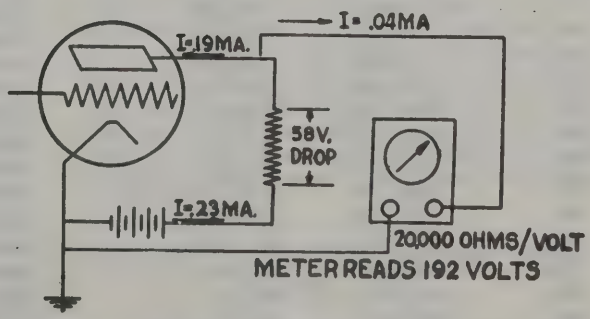
Normal Operation No Meter In Circuit



Conditions Using 125 Ohms Per Volt Meter



Conditions Using 1,000 Ohms Per Volt Meter



Conditions Using 20,000 Ohms Per Volt Meter

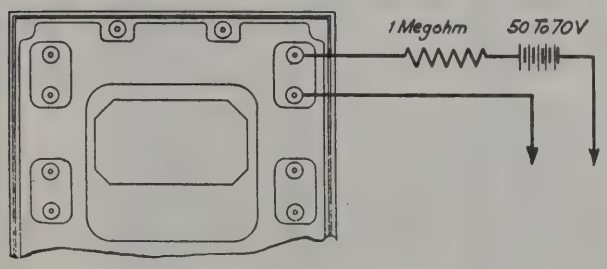
Meter Range—250 Volts Full Scale in All Cases

DECIBEL READINGS

Power Level DB	Volts—Based on 6 M.W. at 0 DB In 500 ohms	600 ohms	Power Ratio to 0 DB	Power 6 MW at 0 DB Watts	Voltage Ratio to 0 DB
-10	0.5477	.6000	0.1000	0.0006000	0.31623
- 9	0.6145	.6732	0.1259	0.0007553	0.35481
- 8	0.6895	.7554	0.1585	0.0009509	0.39811
- 7	0.7737	.8475	0.1995	0.0011972	0.44668
- 6	0.8681	.9509	0.2512	0.0015071	0.50119
- 5	0.9740	1.0670	0.3162	0.0018975	0.56234
- 4	1.0928	1.1972	0.3981	0.0023886	0.63096
- 3	1.2262	1.3433	0.5012	0.0030071	0.70795
- 2	1.3758	1.5071	0.6310	0.0037857	0.79433
- 1	1.5437	1.6910	0.7943	0.0047660	0.89125
0	1.7321	1.8974	1.0000	0.0060000	1.00000
+ 1	1.9434	2.1289	1.2589	0.0075535	1.1220
+ 2	2.1805	2.3886	1.5849	0.0095093	1.2589
+ 3	2.4466	2.6801	1.9953	0.0119716	1.4125
+ 4	2.7451	3.0071	2.5110	0.0150713	1.5849
+ 5	3.0801	3.3741	3.1623	0.0189747	1.7783
+ 6	3.4559	3.7867	3.9811	0.0238865	1.9953
+ 7	3.8776	4.2477	5.0119	0.030071	2.2387
+ 8	4.3507	4.7660	6.3096	0.037857	2.5119
+ 9	4.8816	5.3475	7.9433	0 047660	2.8184
10	5.4772	6.0000	10.0000	0.060000	3.1623
11	6.1455	6.7321	12.589	0.075535	3.5481
12	6.8954	7.5536	15.849	0.095093	3.9811
13	7.7368	8.4752	19.953	0.119716	4.4668
14	8.6808	9.5094	25.119	0.150713	5.0119
15	9.7400	10.670	31.623	0.189747	5.6234
16	10.9285	11.972	39.811	0.238865	6.3096
17	12.2620	13.433	50.119	0.30071	7.0795
18	13.7582	15.071	63.096	0.37857	7.9433
19	15.4369	16.910	79.433	0.47660	8.9125
20	17.3205	18.974	100.000	0.60000	10.0000
21	19.434	21.289	125.89	0.75535	11.220
22	21.805	23.886	158.49	0.95093	12.589
23	24.466	26.801	199.53	1.19716	14.125
24	27.451	30.071	251.19	1.50713	15.849
25	30.801	33.741	316.23	1.89747	17.783
26	34.559	37.867	398.11	2.38865	19.953
27	38.776	42.477	501.19	3.0071	22.387
28	43.507	47.660	630.96	3.7857	25.119
29	48.816	53.475	794.33	4.7660	28.184
30	54.772	60.000	1000.00	6.0000	31.623
31	61.455	67.321	1258.9	7.5535	35.481
32	68.954	75.536	1584.9	9.5093	39.811
33	77.368	84.752	1995.3	11.9716	44.668
34	86.808	95.094	2511.9	15.0713	50.119
35	97.400	106.70	3162.3	18.9747	56.234
36	109.285	119.72	3981.1	23.8865	63.096
37	122.620	134.33	5011.9	30.071	70.795
38	137.582	150.71	6309.6	37.857	79.433
39	154.369	169.10	7943.3	47.660	89.125
40	173.205	189.74	10000.0	60.000	100.000
41	194.34	212.89	12589.2	75.535	112.20
42	218.05	238.86	15848.9	95.093	125.89
43	244.66	268.01	19952.6	119.716	141.25
44	274.51	300.71	25118.9	150.713	158.49
45	308.01	337.41	31622.8	189.747	177.83
46	345.59	378.67	39810.7	238.865	199.53
47	387.76	424.77	50118.7	300.71	223.87
48	435.07	476.60	63095.7	378.57	251.19
49	488.16	534.75	79432.7	476.60	281.84
50	547.72	600.00	100000.0	600.00	316.25

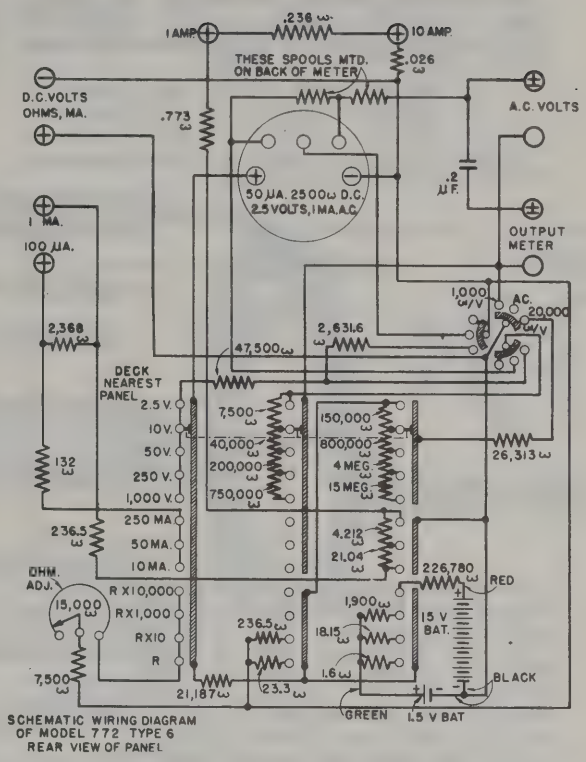
4.3 — Condenser leakage measurements are very valuable in segregating shorted or leaky condensers. The sensitive ohm ranges on the Model 772 make these tests very easy. Measurements of paper condensers should always be made using the top or R x 10,000 range. All paper condensers should not show any appreciable leakage on this range due to the fact that leakage lower than 50 megohms is liable to indicate moisture in the condenser which may result later on in a final breakdown. Electrolytic condensers should in most cases be measured on the R x 1000 range as their resistance is always a finite value somewhere in the low megohm group. A true advantage of a sensitive ohmmeter of this type is shown here where a maximum potential on any range of only 15 volts d.c. is used to obtain the high megohm readings. Any ohm test can, therefore, be taken on any electrolytic condenser regardless of its voltage rating as it will never be exceeded on this model. In general electrolytic condensers used in power supplies should be rejected if their leakage resistance is below 400,000 ohms. Any value much below this will cause heating in the condenser which may in turn result in further injury and final breakdown. On by-pass condensers used on cathode circuits of the 5, 10 and 25 microfarad types with voltage ratings as low as 50 volts, considerably lower resistance readings may be obtained, and where they are shunted by cathode resistors having low values they will probably function alright. However, any electrolytic condenser should have a resistance of at least 100,000 ohms to function correctly in receiver circuits. The condenser should be connected with its + terminal to the — terminal on the tester.

4.4 — A multiplier for the top d.c. ohm range can be made if even higher ohm readings are desired. The extreme sensitivity of the tester makes it possible and by adding 60 volts of "B" battery (anything from 50 to 70 volts will do) in series with the ohm jacks shown in the circuit below a 5 to 1 multiplier giving readings up to 150 megohms may be used. It should be noted that a 1 megohm resistor is used and to obtain accurate readings this resistor should be adjusted to 1%. If the voltage in the battery allows adjustment of the pointer to top mark when the leads are shorted together, the readings on this top range will multiply exactly by 5 if the external resistor used has been accurately adjusted and is so constructed that it will hold its accuracy through moisture and temperature variations. This additional 5 to 1 multiplier is often valuable in measuring paper condensers for leakage as estimates of as high as 200 and 250 megohms can be made by watching the pointer. Top reading on this range would be 150 megohms.



Circuit for Rx50,000 Used on Top or Rx10,000 Ohm Switch Position

Figure 4



SCHEMATIC WIRING DIAGRAM OF MODEL 772 TYPE 6 REAR VIEW OF PANEL

Wiring Diagram for Model 772 Analyzer

4.5 — For those who wish to determine a power level in a 600 ohm line, and for those who wish to refer to a power level table, we add a word of explanation for the use of the Decibel table given in this book. For example on a 600 ohm line with the selector switch in the 10 volt position and a.c. Volt pin jacks connected across the line, a reading of 4.24 might be obtained. This is read on the red a.c. scale. Referring to db readings on the previous page the column headed "VOLTS—BASED ON 6 MILLIWATTS AT O DB." should be located. Under this heading two individual columns should be noted, one entitled "500 OHMS" and the other "600 OHMS." As the particular line in question is a 600 ohm line the operator should run his finger down this column and locate the nearest reading to 4.24. This happens to be the 18th figure in this column, the exact reading here being 4.2477. Referring horizontally to the left-hand column entitled "POWER LEVEL IN DB" a reading of + 7 will be noted. The level on this line is, therefore, + 7 db. or, 7 d.b. above zero level of 6 milliwatts. If the line in question happens to be a 500 ohm line, the db. scale on the instrument may be used or the 2nd column from the left should be referred to. If the power ratio to zero db. is required or the actual power in watts in this particular line is to be determined, then the figure in 4th or 5th column should be located.

CAPACITY MEASUREMENTS WITH MODEL 772

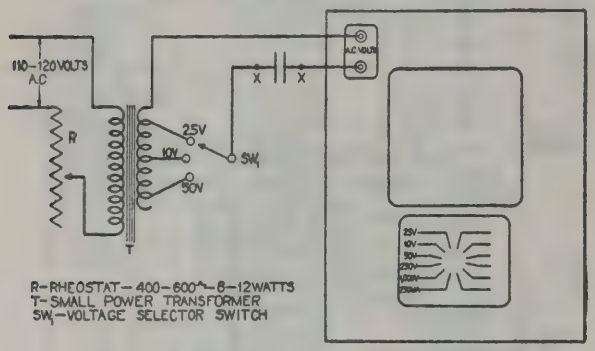
4.6 — Capacity measurements can be made with the Model 772 Analyzer by making use of a small power transformer having 2.5, 10 and 50 volt secondary windings. If only one range of capacity is desired or if a transformer is available with only one of

these potential windings, readings can be taken on just one single a.c. range.

The capacity coverage on the three lower volt ranges of the Model 772 are as follows:

2.5 volts a.c.	— .01	to 10	microfarads
10 volts a.c.	— .005	— 2.0	microfarads
50 volts a.c.	— .0004	— 1.0	microfarads

To make these measurements the wiring diagram as shown below should be followed.



MODEL 772 ANALYZER

1. Connect the transformer through a 400 to 600 ohm rheostat directly across a normal 110 to 120 volt 60 cycle a.c. line.
2. Set up a three point switch or some method of making connection to each of the three secondary taps mentioned above and wire the common of this switch to one test lead and connect the other test lead as shown to one of the a.c. volt jacks.
3. Rotate the range switch on the Model 772 to correspond to the voltage taps as used on this external transformer.
4. Short the test leads "XX" and adjust the series rheostat R until the pointer on the Model 772 instrument indicates exactly full scale.
5. The test leads should then be connected across the condenser to be measured and a voltage reading taken on the a.c. arc 2.5 volt range. This particular range is used for all capacity readings irrespective of the applied voltage to simplify the curves.
6. Refer to the three curves below reading up from the bottom of the left-hand side of the chart to the voltage reading as obtained on the Model 772. Read across horizontally to the voltage range used and projecting down from this point the capacity in microfarads can be obtained directly.

Example

a. Set the transformer tap switch to the 2.5 volt tap.

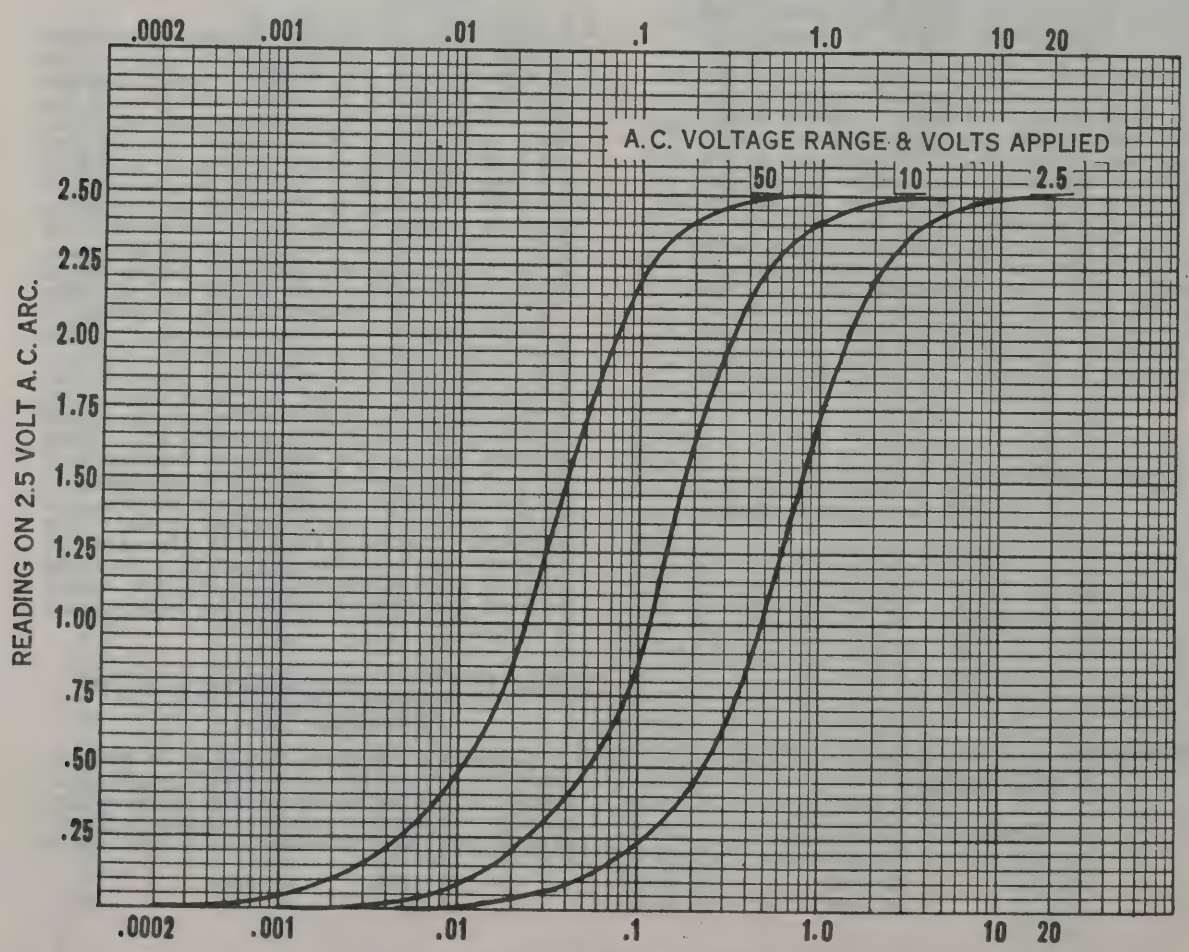
b. Rotate the Model 772 switch to the 2.5 volt position making sure that the functional switch is indexed to the center or A.C. VOLTS position.

c. Short the test leads and adjust the rheostat R for full scale meter deflection.

d. Connect the test leads across the condenser and a reading of say 1.8 volts is obtained.

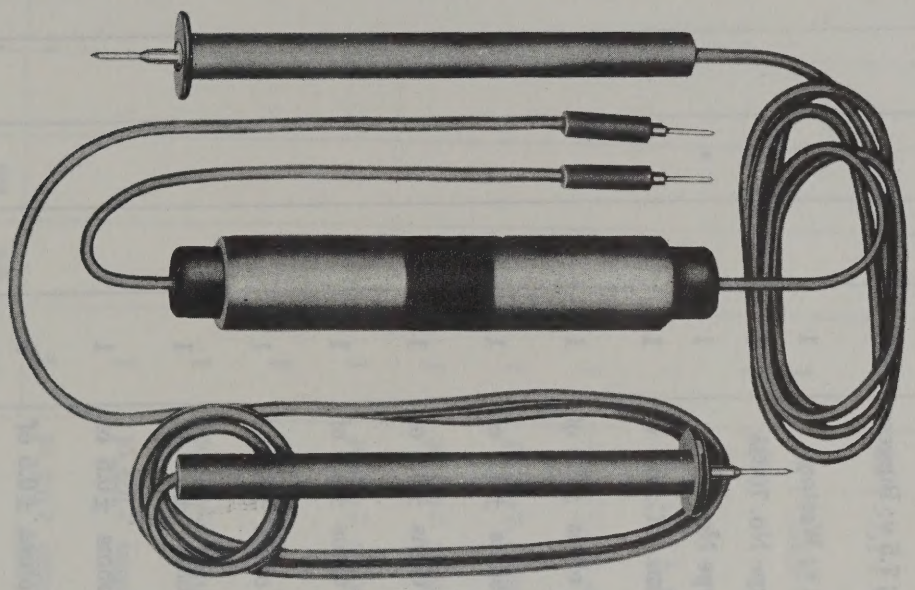
e. Read up on the axis labelled "Indication on 2.5 Volt A.C. Arc" to the reading equal to 1.8 volts and project across to the 2.5 volt curve. Reading down from the point the capacity as measured is 1.1 microfarads.

While this may seem slightly complicated at first, after taking readings on two or three condensers, the procedure will become quite simple and after a little practice capacity readings can be taken quite easily, rapidly and with reasonable accuracy in this way.



CAPACITY CURVES FOR MODEL 772

10,000 Volt D.C. Measurements at 20,000 Ohms Per Volt.



Model 766 Televerter
For use with Model 772 Analyzer

The Model 766 televerter multiplier can be used to extend the range of 20,000 ohm per volt analyzers to 10,000 volts. Potentials of this magnitude are being used in television receivers on the accelerating electrodes of the kineoscope tubes. Because of high resistance coupling circuits, sensitive high range meters, are necessary. With the Model 772 the high sensitivity required is already available and the televerter supplies the necessary range extension.

The televerter and leads afford ample protection and have been manufactured to pass A.I.E.E. dielectric specifications. The resistor tube can be used in position in the clamp, the short lead connected to the minus pin jack marked "DC Volts". The other test lead plugs into the plus "DC Volts" pin jack. It is important that this polarity be observed, as it is standard practice to run the positive end of the power pack of television receivers at ground potential, and therefore, by connecting in this way, the panel of the analyzer is at ground potential and protects the operator from any possible shock.

CARE SHOULD BE EXERCISED WHEN MEASURING HIGH POTENTIALS WITH THIS 10,000 VOLT RANGE. IT IS ADVISABLE TO CONNECT THE POSITIVE LEAD FIRST TO THE CHASSIS AND THEN HOLDING THE NEGATIVE LEAD IN ONE HAND AND KEEPING THE OTHER HAND IN THE POCKET, TO MAKE CONNECTION TO THE REQUIRED POINT IN THE RECEIVER. IN SOME INSTANCES IT MAY BE ADVISABLE TO TURN THE RECEIVER OFF, MAKE THE VOLTMETER CONNECTIONS AND THEN TURN ON THE RECEIVER TO TAKE THE READING.

For readings on this 10,000 volt range, the range switch should be indexed to the 2.5 volt position with the functional switch in the left-hand or 20,000 ohms per volt position. Be sure that these two switches are correctly indexed before using the televerter. Readings can be taken directly on the 100 line d.c. arc in terms of 10,000 volts full scale.

NOTE: Failure or unsatisfactory performance of equipment used by Army Ground Forces and Army Service Forces will be reported on W.D., A.G.O. Form No. 468 (Unsatisfactory Equipment Report). If Form No. 468 is not available, see TM 38-250. Failure or unsatisfactory performance of equipment used by Army Air Forces will be reported on Army Air Forces Form No. 54 (unsatisfactory report).

V. MAINTENANCE PARTS LIST

Ref symbol	Signal Corps stock No.	Major comp	Name of part and description	Quan per unit	Orgn stock 1st ech	Orgn stock 2d ech	3d ech	4th ech	Depot stock
	3A30	I-167-A	BATTERY, dry: Sig C Battery BA-30; 1.5 v; Burgess No. 2 or Eveready No. 950 (unicell).	1		*			*
	3A34	I-167-A	BATTERY, dry: Sig C Battery BA-34; 7.5 v; Burgess No. 5540.	2		*			*
	3DA250-24.2	I-167-A	CAPACITOR, fixed: 250,000 mmf; 600 v; Weston.	1					*
	3F4056/L1	I-167-A	LEADS AND PRODS, test: Weston type No. 70033.	1		*			*
	3F4056/L1	I-167-A	LEADS AND PRODS, test: Weston type No. 70034.	1		*			*
	3F1772.2	I-167-A	METER, multimeter: 50 ma, 2500 ohms DC; 2.5 v; 1 ma AC; Weston.	1					*
	3Z5987-6	I-167-A	RESISTOR, fixed: wire wound; 1.043 ohms ±0.5 of 1%; ½ w; Weston.	1					*
	3Z5991-20	I-167-A	RESISTOR, fixed: wire wound; 1.6 ohms ±0.5 of 1%; ½ w; Weston.	1					*
	3Z5994-26	I-167-A	RESISTOR, fixed: wire wound; 4.212 ohms ±0.5 of 1%; ½ w; Weston.	1					*
	3Z6001H8-12	I-167-A	RESISTOR, fixed: wire wound; 18.15 ohms ±0.5 of 1%; ½ w; Weston.	1					*
	3Z6002A1-6	I-167-A	RESISTOR, fixed: wire wound; 21.04 ohms ±0.5 of 1%; ½ w; Weston.	1					*
	3Z6002C3-3	I-167-A	RESISTOR, fixed: wire wound; 23.3 ohms ±0.5 of 1%; ½ w; Weston.	1					*
	3Z6013B2	I-167-A	RESISTOR, fixed: wire wound; 132 ohms ±0.5 of 1%; ½ w; Weston.	1					*
	3Z6023F6	I-167-A	RESISTOR, fixed: wire wound; 236.5 ohms ±0.5 of 1%; ½ w; Weston.	1					*

* Indicates stock available.

V. MAINTENANCE PARTS LIST (contd.)

Ref symbol	Signal Corps stock No.	Major comp	Name of part and description	Quan per unit	Orgn stock 1st ech	Orgn stock 2d ech	3d ech	4th ech	Depot stock
	3Z6190-8	I-167-A	RESISTOR, fixed: wire wound; 1,900 ohms ±0.5 of 1%; ½ w; Weston.	1					*
	3Z6236H8	I-167-A	RESISTOR, fixed: wire wound; 2,368 ohms ±0.5 of 1%; ½ w; Weston.	1					*
	3Z6575-68	I-167-A	RESISTOR, fixed: wire wound; 7,500 ohms ±0.5 of 1%; ½ w; Weston.	1					*
	3Z6576-19	I-167-A	RESISTOR, fixed: ceramic; 7,500 ohms ±1%; 1 w; Weston.	1					*
	3Z6621A1	I-167-A	RESISTOR, fixed: wire wound; 21,187 ohms ±0.5 of 1%; ½ w; Weston.	1					*
	3Z6640-70	I-167-A	RESISTOR, fixed: wire wound; 26,313 ohms ±0.5 of 1%; ½ w; Weston.	1					*
	3Z6626C3	I-167-A	RESISTOR, fixed: wire wound; 40,000 ohms ±0.5 of 1%; ½ w; Weston.	1					*
	3Z6715-54	I-167-A	RESISTOR, fixed: ceramics; 150,000 ohms ±1%; 1 w; Weston.	1					*
	3Z6720-44	I-167-A	RESISTOR, fixed: ceramic; 200,000 ohms ±1%; 1 w; Weston.	1					*
	3Z6722F6	I-167-A	RESISTOR, fixed: 226,780 ohms; Weston.	1					*
	3Z6775-20	I-167-A	RESISTOR, fixed: ceramic; 750,000 ohms ±1%; 1 w; Weston.	1					*
	3Z6780-2	I-167-A	RESISTOR, fixed: ceramic; 800,000 ohms ±1%; 1 w; Weston.	1					*
	3Z6804-14	I-167-A	RESISTOR, fixed: ceramic; 4 meg ±1%; 1 w; Weston.	1					*
	3Z6815-3	I-167-A	RESISTOR, fixed: ceramic; 15 meg ±1%; 1w; Weston.	1					*

* Indicates stock available.

V. MAINTENANCE PARTS LIST (contd.)

Ref symbol	Signal Corps stock No.	Major comp	Name of part and description	Quan per unit	Orgn stock		3d ech	4th ech	Depot stock
					1st ech	2d ech			
	2Z7270-173	I-167-A	RESISTOR, variable: carbon; 15,000 ohms; IRC (potentiometer).	1					*
	3Z9825-5.1	I-167-A	SWITCH, rotary: 3 positions; Weston.	1					*
	3F1716	I-167-A	ANALYZER: I-167-A						*
	3Z6902	I-167-A	RESISTOR, fixed: 200 meg ±5%; 10,000 volts. (Bakelite housing; 1 1/10″ dia. x 5 1/4″ long: doubly sealed against moisture; concentric female terminals at each end; Televerter Unit, Weston Model No. 766 Type 2.)						*

* Indicates stock available.

Order No. 473-MPD-43; 1047 Copies, 15 November 1944.